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July 2017
Issue 443

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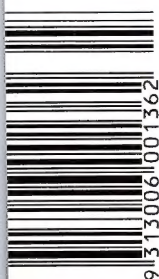
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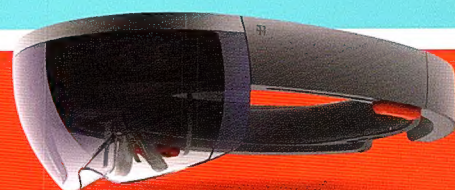
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- CREATE AND SCULPT 3D MODELS USING VIRTUAL CLAY

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Vigor2860Ln



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* Vigor2860L/Ln only has one USB port.

Vigor2760 Series

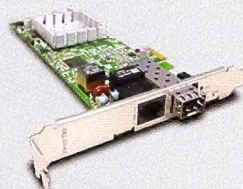
VDSL2/ADSL2+ & Gigabit Ethernet WAN router with Security Firewall, and 2 x VPN tunnels including SSL-VPN tunnels



- 1 x VDSL2/ADSL2+ WAN port
- 1 x Selectable Gigabit Ethernet WAN/LAN port
- 3 x Gigabit Ethernet LAN ports
- VDSL2 vectoring
- 2 x USB ports for 3G/4G LTE mobile broadband access, USB printer and storage
- 2 x VPN tunnels including 2 x SSL-VPN tunnels
- Built-in object-oriented firewall
- IPv6 & IPv4
- 802.11n Wi-Fi (n model)
- VoIP (V model)
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- VDSL2 vectoring
- Bridging for VDSL2 and ADSL2+
- Built-in object oriented firewall
- IPv6 & IPv4
- Works with VigorACS SI management system



i-LAN Technology Pty Ltd trading as DrayTek Aust & NZ

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Are Western security services undermining our digital security?

APC's editor says the recent WannaCry attack has clearly demonstrated why creating encryption backdoors for law enforcement is a recipe for disaster.

Is the NSA to blame for the massive WannaCry global ransomware infection? That's what Microsoft – whose Windows OSes were the target of the attacks – seems to be saying, as the tech giant came out swinging against the NSA and CIA for hoarding known OS vulnerabilities (see tinyurl.com/apc443-wcry). And indeed, WannaCry did use two NSA-discovered exploits as the engine for driving the malware – exploits which were leaked to the internet in April by hacker group the Shadow Brokers, which had previously been trying to sell its discoveries to the highest bidder. (Nobody took them up on the offer, which is why they were released for anyone with nefarious intent to make use of.)

To its credit, Microsoft had released patches for these exploits back in March, so both individual users and sysadmins have to take at least some share of the blame for WannaCry's broad infection rate, which affected some 200,000 systems worldwide. Some 98% of the infected PCs were running Windows 7 – that's not too surprising, given that it has the largest share of the market (around 48%) and the fact that it is still the most broadly-employed OS in businesses, which can often delay

rolling out security updates to ensure they aren't going to break anything.

If there's a broad message to be taken out of WannaCry, it's that – as inconvenient as they might often be – you should always install the latest OS updates for your devices. But it also entirely undermines US (and other) intelligence agencies' frequent requests for backdoors into the products of Apple, Google and Microsoft to help with law enforcement. All three companies have recently stepped up their efforts to encrypt their products to better protect their customers from attacks.

We've built a world that's heavily reliant on digital infrastructure – one that's hard enough to secure without having to worry about deliberate holes in the defences. What's to guarantee that, as with the NSA exploits at the heart of WannaCry, these backdoors won't be discovered and exploited by hackers to the detriment of us all? ■



DAN GARDINER
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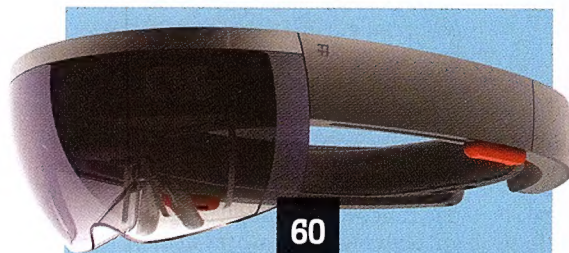
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It could revolutionise everything from medicine to online shopping and just one implementation of this tech generated over US\$950 million in 2016.

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"Heat spreads out and warms up the palm-rest area — though thankfully, that's generally only to a comfortable 'kitten on your lap' level." Razer Blade (2017), page 18



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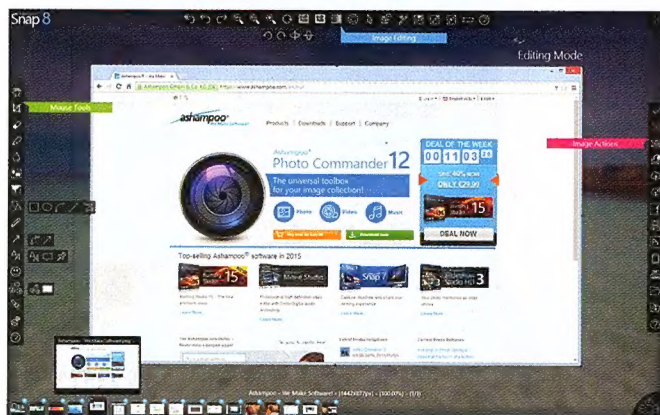
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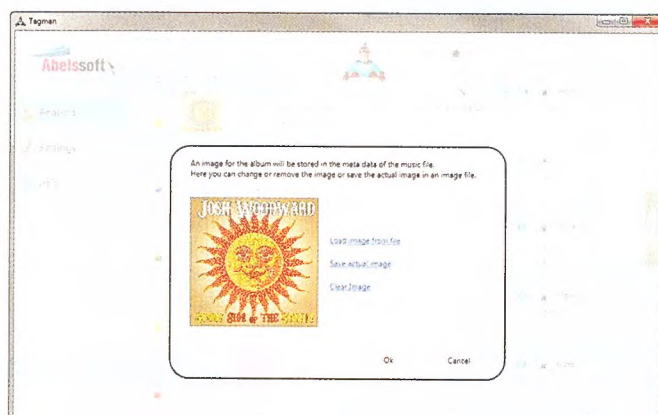
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Razer Blade (2017)

Is this middle-child in Razer's laptop family just right, or does sleekness come at too great a cost?

It's hard to believe that Razer's Blade line of portable gaming laptops only launched back in 2013, with this main 14-inch model now in its sixth hardware refresh. While it's also surprising to us that no other company has managed to match Razer's premium unibody design, which makes the Blade as sleek as a gaming MacBook as you'll find. The build quality is undeniable with fire-breath trackpad and keyboard and a chassis that can take a lot of punishment.

That's the last right-sitting in the Blade family—its bigger and more powerful than the 12.5-inch Blade Stealth (thanks mostly to its having a dedicated Nvidia GPU), the Blade Pro, which packs a GTX 1080 and as a 17.3-inch behemoth, with the top-end option curving like a 27-inch.

Razer doesn't offer a heap of customisability in the

2017 Blade, opting for just a single high-end CPU/RAM config in a pretty quad-core i7770HQ paired with 16GB DDR4, with either a glossy 4K touchscreen or a matte-finish 1080p (non-touch) display; as well as three choices for SSD size (256GB, 512GB or 1TB). We tested the bottom 1080p/512GB model, which goes for a fairly reasonable \$2,299.

Those specs ultimately get you a very good all-rounder that can tackle any task you need, including playing most games at Ultra detail settings, as well as editing high-end images and videos. It's also relatively quiet when it comes to gaming, bling—the only marginally offensive element in the rainbow-backlit keyboard, which by default is set to a relatively dim, fast-moving colour spectrum wave. You need to sign into Razer's Synapse software to change that, but once you do, it's a no-brainer. Innocuous as dedicated gaming laptops come.

The matte-black unibody aluminium chassis is, as always, as tough as a pair of steel-egged boots, although there are a couple of areas where the Blade design is looking a bit dated. The 14-inch display bezel, for example, are quite wide about an inch on all sides, making them gargantuan next to the 2mm ones on Gigabyte's Aero 15 opposite.

While we're comparing, Razer's slightly thinner design (17.9mm vs 19.4mm) means its cooling system isn't quite as efficient as the Gigabyte's, with the Blade's GPU getting about 10°C hotter while gaming, reaching a peak of 50°C. The conductive nature of the Blade's all-metal chassis means that heat seeps out and warms up the palm-rest area—though, thankfully, that's only to comfortably kitten on your lap, I assure.

This unit got moderately loud when gaming. While the fans can take 5-10 minutes to really ramp up, once they kick into high-gear you'll

clearly hear them if you're in the same room, so grab some headphones if you're gaming. Mercifully, the Blade's pretty quiet to switch these fans when you're not gaming.

The overall value here isn't quite as impressive as some other gaming laptops around this price, as you're getting extra storage and fewer expansion ports. So you're paying extra for the Razer brand name and the Blade family's high-quality components, although as this one's thermal numbers show, even quality parts don't always stand up well in the face of real hard physics.

—Dan Gardner

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Continuing 'hot and gaming' means Razer's Blade is one of the best performing as appealing high-build quality

LAIPS		RECHARGEABLE BATTERY	
Weight (kg)	2.29	Weight (kg)	2.29
Thickness (mm)	17.9	Thickness (mm)	19.4
Display (inches)	14	Display (inches)	15
Processor (CPU)	i7-7700HQ	Processor (CPU)	i7-7700HQ
RAM (GB)	16	RAM (GB)	16
Storage (GB)	512	Storage (GB)	512
GPU	GTX 1080	GPU	GTX 1080
OS	Windows 10	OS	Windows 10
Price	\$2,299	Price	\$2,299

Gigabyte Aero 15

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DrayTek Vigor2952P

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Find out all about APC's editorial policies, test practices, how to read the benchmark results and more.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And like you, APC's journalists want to know what's good in tech — no matter what platform it resides on.

Championing technology doesn't mean we're unrelenting yes-men, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

Despite being a small magazine with limited resources, APC still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule and where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.

Hackers are now hiding malware in subtitle files

WATCH WHAT YOU WATCH.

Cyberattacks come in all forms — now hidden within subtitles files of videos played on vulnerable media players. It's recently been reported that hackers are embedding code in subtitled pirated movies and TV shows, files which are often overlooked by users. Fortunately, most of the popular media players like VLC, Kodi and Popcorn Time have set up fixes to combat the issue and users have been encouraged to update their media players. **SS**

Facebook's attempts to fight fake news backfiring

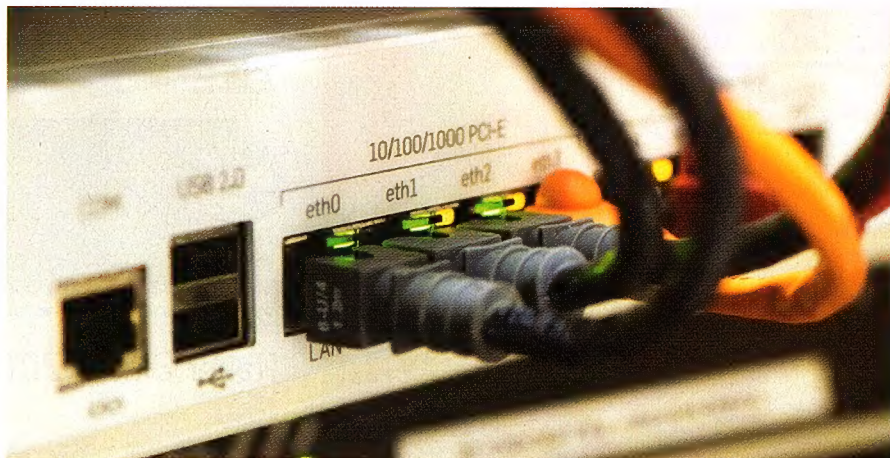
APPARENTLY, SOME PEOPLE PREFER THE FAKE STUFF.

Facebook may have unleashed a set of tools to combat fake news, but they don't seem to be very effective. It's found stories labelled 'disputed' often go viral — thanks to reverse psychology playing its part — the label itself tends to appear only after the news has spread like wildfire or fake stories remain on the site for a substantial amount of time without being tagged. Facebook has refused to reveal any data to prove whether its system is working or not. **SS**

After success against Oculus, ZeniMax is now suing Samsung over Gear VR

SHOW ME THE (VIRTUAL) MONEY!

After successfully suing Facebook for \$500 million in damages, gaming company ZeniMax is now going after Samsung's Gear VR headset which is "powered by Oculus". The lawsuit claims that the South Korean manufacturer knowingly profited from the technology misappropriated by Oculus executive John Carmack, and also accuses Samsung of copyright infringement, trade secret misappropriation, unfair competition and unjust enrichment. **SS**



'NBN tax' gets ACCC approval, could bring price-hike for some fibre internet users

Decision means customers could cop the cost.

The ACCC has ruled that it's fine for the burden of funding the NBN's Regional Broadband Scheme (RBS) to disproportionately fall on customers of superfast fibre-internet services that were rolled out privately. The ruling is likely to mean that some internet users in new housing estates and inner-city blocks of flats could face their ISP levying an 'NBN tax' on their internet service. This is expected to take the form of an extra monthly fee of around \$7, and could come into effect as early as June this year. The tax is intended to help subsidise the costs of the government's rollout of NBN infrastructure (including fixed wireless and satellite components) to regional parts of Australia that would otherwise not be financially viable.

The fee will only affect superfast internet services that aren't technically part of the NBN, which have often been rolled out privately in regions and situations that wouldn't have otherwise been serviced. This move aims to prevent these non-NBN providers from having to absorb the costs themselves. The ACCC has also specified that it won't apply to smaller providers with fewer than 12,000 customers, where it's feared the increased burden could be crippling.

Harry Domanski

Android creator's new phone is Essential

ALTHOUGH IT MIGHT'VE DROPPED A FEW 'ESSENTIAL' FEATURES...

Andy Rubin is the man behind the Android OS, but he apparently doesn't much like the "weird new world" we live in, where smartphones come with "unnecessary features cluttering our lives". In a bid to change that, Rubin's releasing his own smartphone with a scratch-proof ceramic-and-titanium body and modular design that'll let owners add accessories to change functionality. Christened the Essential Ph-1 (commonly known as the Essential Phone), it features a flat 5.7-inch (2,560 x 1,312-pixel) edge-to-edge display (called a 'Full Display' by Essential) and all the other flagship smartphone technologies we've come to expect, like a high-end Qualcomm processor, 4GB of memory and 128GB of storage, fingerprint sensor, and dual cameras. What it does lack, however, is a headphone jack, although like the iPhone 7, it's been reported that the Essential will ship with a 3.5mm adapter-dongle in the box.

The handset will run a version of Android with a customised user interface that promises to evolve with the user. The phone is being touted as "interesting", but is it actually interesting enough to compete against the likes of Apple and Samsung? There's, as yet, no word on an Australian release date. **Sharmishta Sarkar**

Apple blames exploding Beats headphones on third-party battery

TALK ABOUT A RUDE AWAKENING.

Apple is blaming third-party batteries for a pair of its Beats headphones that exploded on an aeroplane mid-flight earlier this year, injuring a woman as she slept. The Australian woman sought compensation for the cost of her damaged clothing and to replace the headphones (although not for the injuries she sustained, curiously enough), but Apple has claimed that the fault lies in third-party AAA batteries that were being used and not the headphones themselves. **HD**

US Net Neutrality laws once again under threat

FCC VOTES TO LOWER BROADBAND CLASSIFICATION.

America's Federal Communications Commission (FCC) has voted to roll back the classification of broadband internet from a Title II to a Title I service. A Title II service is one that is regulated as a utility (like gas, water and electricity), meaning that all data across the network would be treated equally if it adheres to the law, but a Title I service has far fewer regulations. Supporters of the move claim it will give ISPs more ways to monetise their networks, while opponents (which include the likes of Google and Facebook) say it could create an unfair system, where customers must pay a premium for unfettered access to sites that use more bandwidth, such as video-streaming services like YouTube and Netflix. **HD**

The MP3 has 'officially' died, as inventor ends licensing

NOT ACTUALLY 'DEAD' DEAD; CAN STILL BE USED FREELY.

In a mostly-symbolic move, the founders of the compressed audio format at the Fraunhofer Institute have ended its licensing for specific MP3 patents. You can still listen to and create MP3s freely, but the dropping of support for the format heralds a shift toward more advanced codecs in the field. For instance, the newer and widely-used AAC format offers more functionality than the MP3 and, most importantly, more efficient compression for better quality audio at smaller file sizes. **HD**



Leaked documents reveal how Facebook handles sex and violence

Ethical dilemmas abound...

An investigative report by *The Guardian* has exposed a number of documents and manuals used to train Facebook's moderators, revealing the type of content users are and aren't allowed to post on the social networking site. For instance, it's allegedly Facebook's policy to not immediately remove livestreaming videos of people attempting self-harm, but to wait until "there's no longer an opportunity to help the person ... unless [the videos] are newsworthy".

Facebook currently has around 4,500 content moderators whose sole job it is to wade through reports from users of disturbing or inappropriate content, and the company has said it plans to hire another 3,000 to help deal with the massive workload. While this army of screening staff deal with these reports, they apparently don't touch any of the content when it first gets posted – that job is instead relegated to automated systems and checks.

These issues are obviously ethically complex, and for many people, it will be irksome to see these topics discussed through the lens of corporate interest – no matter how reasonable the policy surrounding each problem may be.

Harry Domanski

NBN name and shame

ACCC TO MONITOR ISP'S NBN SPEEDS, PROVIDE RESULTS TO PUBLIC.

In an effort to hold ISPs accountable for the quality of service they provide to customers, communications minister Senator Mitch Fifield has announced a new Broadband Performance Monitoring and Reporting (BPMR) program that will be funded by the federal government and overseen by the Australian Competition and Consumer Commission (ACCC). Reportedly costing \$7 million over four years, the scheme will see monitoring hardware installed in roughly 4,000 volunteer households around the country. "This program will see the ACCC test and report on the typical speed and performance of broadband plans provided over the NBN," said ACCC chairperson Rod Sims, further explaining that the "information will assist consumers in comparing and shopping around, and checking that they receive what they are paying for." According to the ACCC, the program will kick off immediately with comparative data expected to be released to the public during the second half of the year. The BRMR will be based on a three-month pilot program that took place in Melbourne in 2015. **Stephen Lambrechts**

technotes

» HARRY DOMANSKI LOOKS AT THE NUMBERS DRIVING THE BIG TECH NEWS



WHAT SOMEONE BOUGHT WITH 10,000 BITCOINS IN 2010, AN AMOUNT NOW VALUED AT US\$20M.

Just over seven years ago, a programmer purchased two large pizzas using his then relatively new cryptocurrency, exchanging 10,000 Bitcoins for the cheesy feast. Although only worth around \$40 at the time, the value of those same Bitcoins now sits around the US\$20 million mark (or AU\$26.7 million). May 22, the date of the original pizza-requesting post, is celebrated amongst the cryptocurrency community as 'Bitcoin Pizza Day' and is thought to be the first record of a real-world transaction using cryptocurrency.



4.9%

WORD ERROR RATE OF GOOGLE'S SPEECH RECOGNITION TECHNOLOGY.

With the growing prevalence of digital voice assistants and speech commands, Google's CEO Sundar Pichai announced that the word error rate of its speech recognition technology has been whittled down to 4.9% — meaning that roughly every 20th word will be misheard. That may sound a little high, but it's almost half the rate from a year ago in July 2016, when it was quoted as 8.5%, and an incredible reduction since 2012 when it was hovering around the 40% mark, suggesting an ever-increasing refinement of the technology.



10%

HOW MUCH AUSSIE TECH RETAILERS COULD DROP THEIR PRICES TO COMPETE WITH AMAZON AU.

When Amazon hits Australian shores, it will likely undercut the major local retailers, in spite of the fact that these bricks-and-mortar stores, such as JB Hi-Fi and the Good Guys, typically sell premium and flagship devices for less than Amazon. (It's at the middle and budget end of the market that Amazon's prices are often most aggressive.) Analysis predicts that this will force existing retailers to drop some prices by around 10% to compete, resulting in a period of cheaper consumer tech.



\$300 million

AMOUNT OF MONEY AUSSIERS LOST TO SCAMMERS IN 2016.

In figures reported by the Australian Competition and Consumer Commission (ACCC) and the Australian Cybercrime Online Reporting Network (ACORN), Australians were fleeced of at least \$300 million by scams throughout the course of 2016. The most successful rorts were investment scams, followed closely by dating scams, which raked in \$59 million and \$42 million, respectively. "What is most concerning is that we are seeing scams getting nastier than ever before," said ACCC deputy Delia Rickard, "there are a lot more threat-based scams targeting vulnerable people."



2 billion

AMOUNT OF ACTIVE ANDROID DEVICES.

At Google's I/O developer event in mid-May, CEO Sundar Pichai announced a range of impressive stats relating to the company's core products, but perhaps the biggest milestone among those was that Android is now being used on more than 2 billion active devices. Pichai attributed the success to the immense and rapid growth of mobile devices in general, saying it's great for the company's intended shift to an "AI-first approach", as more people buy into Google's media and app ecosystems. ■

techbrief

» CARMEL SEALEY WADES INTO A CURRENT NEWS TOPIC TO TAKE A CLOSER LOOK



Holding the world to ransom

The WannaCry ransomware spread to hundreds of thousands around the globe, affecting single individuals and large organisations alike.

WannaCry was unleashed on the 12th of May in what has been described as the biggest worldwide cyberattack yet. The 'cryptoworm' spread incredibly fast, infecting more than 200,000 computers in over 150 countries within the first day alone. This particular brand of ransomware infiltrates the victim's computer and encrypts data before displaying a message onscreen, demanding a payment of either \$300 in bitcoin with a deadline of three days, or \$600 for seven days. Many large companies were hit in the attack, but more disturbing is the number of government organisations that fell victim to WannaCry, including several state, official ministry offices, hospitals, universities and colleges, rail networks, police systems and security organisations. While new cases of infection have now slowed to a trickle — due to a kill switch having been discovered and infected computers receiving overdue updates — the worm has left a trail of destruction in its wake that will undoubtedly lead to many organisations rethinking their current digital security measures.

WannaCry causes cyber security and insurance companies' stocks to rise

While it's still a bit early to deduce the full scope of WannaCry's negative financial impact, many are already reassessing their own security measures and seeking insurance claims, leading investors to look more attentively at the cyber-security market. Both BlackBerry Cybersecurity Services and FireEye saw 7% surges in stocks in May, indicating that people's digital security awareness has been heightened — potentially the only upside to the attack.

Not all that glitters is a ransomware fix

Unfortunately, there are and always will be scammers — those who seek to profit by exploiting people's fears; and here, in the wake of WannaCry, malware is masquerading as antivirus solutions. Many security companies have scrambled to release updates and scammers have taken this opportunity to attempt to sell people their own 'patches'. Be very wary of third-parties promising to sell you solutions to Windows security vulnerabilities, as Microsoft will only make these downloads available through its official channels.



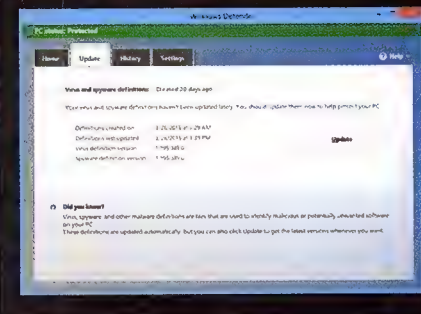
Was North Korea behind it?

According to researchers at security firm Symantec, "the technical evidence points to the fact that this is Lazarus". If that name sounds familiar, cast your mind back to 2014 when Sony Pictures was hit by a hacker group calling itself the Guardians of Peace. Analysis carried out by Novetta states that there was a "long trail of activities attributed to the Lazarus Group" and that the attack was carried out by "a more structured, resourced and motivated organisation" than hactivists. Due to the fact the Guardians of Peace demanded Sony to stop the distribution of its film *The Interview* (a comedy in which two men plot to assassinate Kim Jong-Un), suspicion was rife that North Korea had sponsored the attack.

Fast-forward to 2017, and Symantec has said "similarities in code and infrastructure" have been found between the Sony attack and WannaCry, suggesting that the Lazarus group was behind it and that North Korea may again be involved. However, some have criticised Symantec (and other companies who agree, such as Kaspersky Lab) for making such claims, saying that Lazarus has never been proven to be a North Korean-sponsored group.

Windows 7 the hardest hit

Research from security firm Kaspersky indicates that more than 98% of affected Windows devices were on some form of Windows 7. While that might sound as though Windows Defender has some explaining to do, it's unclear at this stage how many of those devices had third-party malware protection installed. Since Microsoft has admitted that Defender should not be solely relied upon — and wouldn't have worked anyway, since it only protects against spyware — some blame must be laid at the feet of individual users and companies for failing to update and/or protect themselves.



technotes

» GEAR WE WANT

PHILIPS SCRENEO 2.0

For them without a lot of space.

\$2,450 | WWW.PHILIPS.COM.AU

So you haven't got the space for a full-on projector mounting and a room-wide sound system? Why not enjoy big screen viewing in small rooms with this ultra short throw projector. With Full HD native resolution and a built-in 26W sound system, it's half big-screen TV, half soundbar. And did we mention it looks great?



PRIZM

The pinnacle of automated music selection

€149 | WWW.MEETPRIZM.COM

This musically inclined pyramid, dubbed Prizm, wants to replace Pandora or Spotify as your hardwired household DJ. Plugging into your existing stereo through a 3.5mm audio jack, an optical audio cable or a Bluetooth connection, Prism syncs the speakers with a music profile you create in the Prism app and then plays you custom tracks, which are selected by an AI music algorithm. If this sounds largely achievable already, the device mixes a little more complexity in with its ability to sync fitness trackers and phones to a profile. When these paired devices are within range of a Prism, the AI will include their musical preferences into its music selection algorithm.

JB

GOOGLE HOME

Google will finally lay its home automation roots Down Under.

AU PRICE TBC | MADEBY.GOOGLE.COM/HOME

Google's Amazon Echo-like household assistant hub, called Home, has been available in the US since the end of 2016 and the UK since April, and now it's finally been confirmed for Australia. Running the Google Assistant app that's also found in the flagship Pixel smartphones (and select other Android handsets), Home should be arriving by the 'middle of the year', according to an announcement made at the company's annual Google I/O developer conference. Whether you want to search the web, control your music, make lists, set appointments, read emails or tweak smart home devices with your voice, Google Home hopes to operate as your smarthome's central hub. Exact details on release date, pricing and the final Australian feature set of Google Home were still to be confirmed at the time of press, but we're hoping Alphabet will spell it out for us soon.

JB





BITFENIX PORTAL

The cake is a l— Stop it. Stop it!

\$187 | WWW.BITFENIX.COM

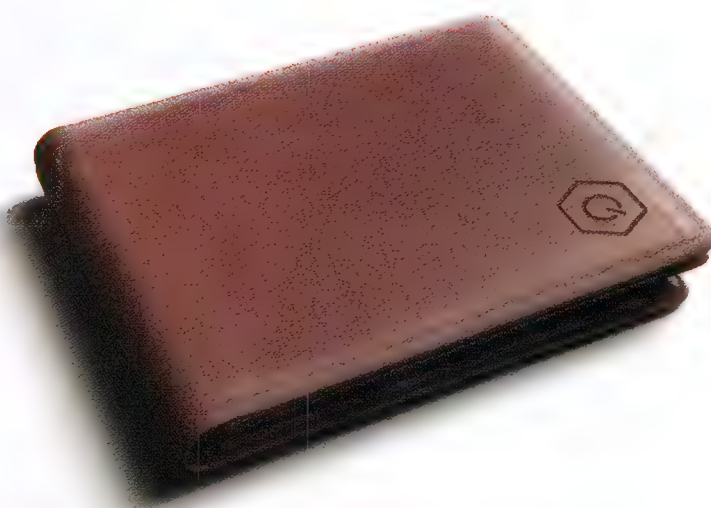
BitFenix was the pioneer of turning the ITX chassis into more than just another low form factor. In 2012, it launched the Prodigy, ruffling the feathers of the purists with a quirky, graceful, willowy box, far bigger than anyone had seen before, and packing a huge 230mm fan in the front. The Portal takes that innovative pedigree and crams it into a new style of chassis unlike anything else. A convex roof adorns the top, ready to show off the heart of any gaming system, while the small form factor and outlandish design make it look like something from *Alien*, or indeed *Portal*. Combine that with its sliding rail internal mechanism, to allow for easy construction and tinkering, and what you're left with is a chassis that takes innovation and case design to new heights, without necessarily breaking the bank. **ZS**

POQIT

Poke it in your pocket.

€143 | POQIT.BERLIN

Pronounced 'pocket' (rather than the other immature potential pronunciations we could come up with), this neat-looking leather wallet packs a little more tech than your general beef-skin money holder. Topping its feature list is a 2,500mAh battery pack that'll be able to give many smartphones a full second charge — but perhaps more uniquely, it'll do this without the clutter of any cords using the near-universal Qi wireless charging standard. The silver (well, some form of silvery metal) lining on the PoQit wallet will also create a radio frequency identification (RFID) blocking safehouse so your credit cards don't get skimmed, and it even has a two-way Bluetooth ringing feature, which'll buzz either your phone or wallet (depending on which one you've lost) through a smartphone application. **JB**



SOUND OASIS BST-100

Bluetooth sleep sound therapy system.

US\$60 | SOUNDOASIS.COM

The BST-100 is a 'sleep sound machine', which basically translates to a device developed by sound therapists and doctors to create white noise to help you drift off to sleep and hopefully stay there. Pre-loaded with 10 sounds, from steady rain to simple white noise, this rechargeable kit blankets your room in soothing sound for eight hours at a time, lulling you into a restful sleep. You can also stream music playlists from your phone to the device via Bluetooth during the day, but it is recommended (by the professionals mentioned above, we presume) that you stick to the sounds provided in the Sound Oasis Therapy Pro App to help you get some quality shuteye at night.

tech

» HOW IT'S DONE



MacBook Pro 15-inch Touch Bar

Repair it? Not if Apple has a say...

Apple announced a trio of new laptops in late 2016, and today we're looking at the top of the line model with Touch Bar, which attempts to replace our tried-and-true function keys. It's time to tear down the 15-inch MacBook Pro with Touch Bar!

MAJOR TECH SPECS

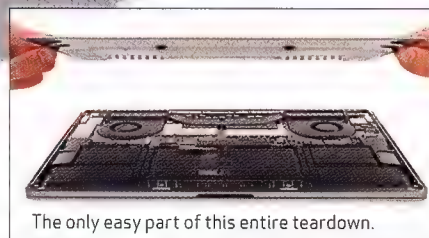
- 15.4-inch LED-backlit Retina Display with 2,880 x 1,800 resolution (220dpi), P3 color gamut
- 2.6GHz Skylake quad-core Intel Core i7 (Turbo Boost up to 3.5GHz), with integrated Radeon Pro 450 with 2GB of GDDR5
- 16GB of 2,133MHz LPDDR3 onboard memory
- 256GB PCIe-based onboard SSD (configurable to 512GB, 1TB or 2TB SSD)
- 4 x Thunderbolt 3 (USB-C) ports supporting charging, DisplayPort, Thunderbolt, USB 3.1 Gen 2
- Touch Bar with integrated Touch ID sensor
- Force Touch trackpad

KEY FINDINGS

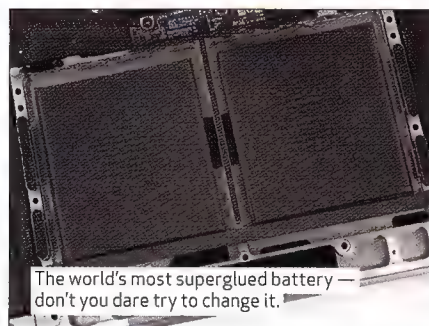
- On initial inspection, the 15-inch looks like a scaled-up version of the 13-inch model. We do notice a difference in the battery layout, but overall, it's like looking at twins. We ran into a connector to nowhere, too. Apple may have included this to access the soldered-in SSD for data recovery. Honestly, we'd rather see a removable/upgradeable SSD in a machine targeted at pros — but this way, if your logic board bites the dust, there might at least be a chance of recovering your data.
- Anxious to get a peek at Apple's re-engineered thermal architecture, we free the fans from the four T3 screws securing them to the rear case and they come out hassle-free. No glue on the outside, then, but opening up the fan takes some aggressive prying against clips and adhesive.
- This 15-inch Pro has a similar speaker grille to its smaller 13-inch brother. Most of the grille doesn't include full through-holes, prompting us to question: why the dimples? Survey says: weight-savers, so it goes faster when you put wheels on it.

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit: www.ifixit.com



The only easy part of this entire teardown.



The world's most superglued battery — don't you dare try to change it.

- After accidentally separating the digitiser from the OLED panel, we turn our tools to the LED display. Two teardown engineers, an opening pick, X-Acto knife, isopropyl alcohol, a heat gun and an iOpener all came to this OLED teardown party, but Apple's adhesive was still too much for our glue separation squad. Thwarted by the monstrous amount of adhesive holding in the OLED panel in place, we resign ourselves to flecking away shards of glass.
- **Repairability Score:** 1 out of 10 (10 is easiest to repair). The trackpad is easy to access and straightforward to replace. Use of proprietary pentalobe screws makes servicing and repair unnecessarily difficult. The entire battery assembly is strongly glued into the case, complicating replacement. The processor, RAM and flash memory are soldered to the logic board. The Touch Bar adds a second, difficult-to-replace screen to damage. The Touch ID sensor doubles as the power switch, and is paired with the T1 chip on the logic board. Fixing a broken power switch may require help from Apple or a new logic board. ■



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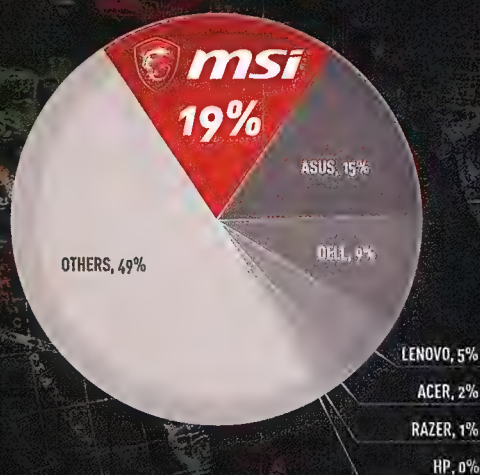
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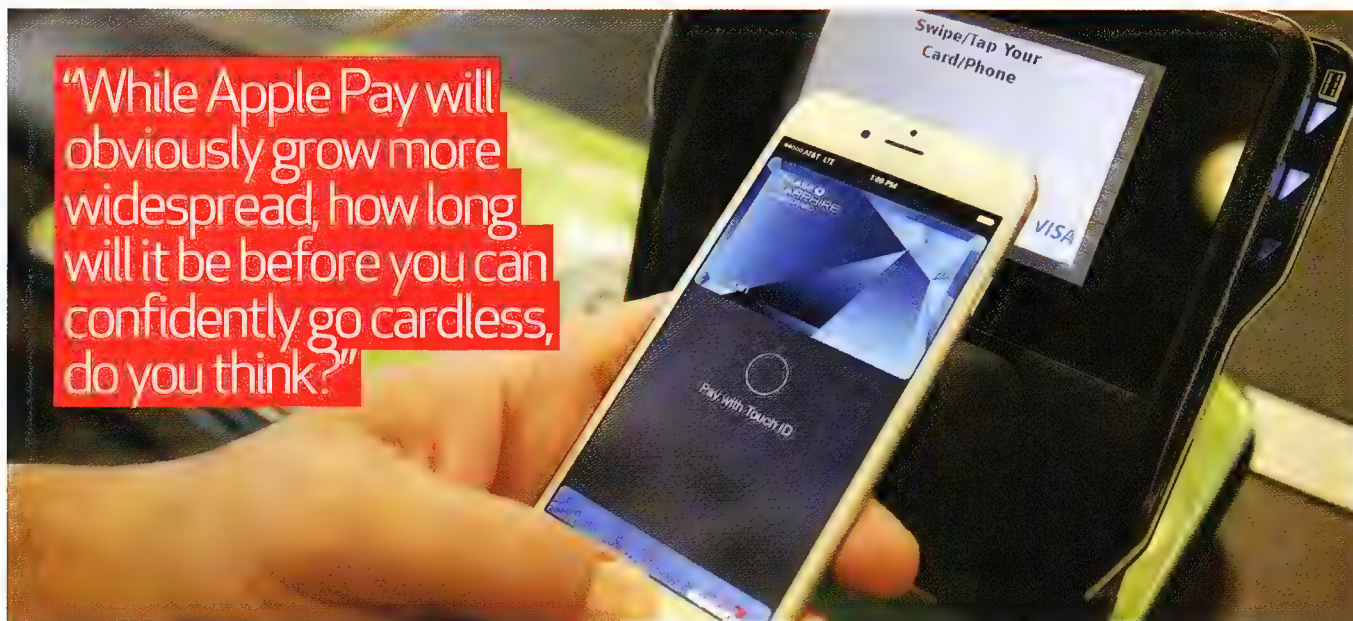


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TRUE GAMING

technotes

» EPINIONS



I WOULD NOT TAP THAT

I consider myself quite 'with the times' when it comes to technology; however, when it came to Apple Pay (and Android Pay, Samsung Pay and the rest), I was rather hesitant. A friend of mine changed banks just to be able to use Apple Pay – which I thought was rather drastic – so eager was he to get on board the progress train. However, at present, if you're heading up to the shops or out for dinner, there's no guarantee that your host will have Apple Pay available (not to mention whether your Apple Watch or iPhone will have enough charge by the end of the night), so you'd still have to bring your card with you just in case. And if you're heading to the pub, you have to keep your ID on you anyway, so you may as well bring your wallet.

While Apple Pay will obviously grow more widespread, how long will it be before you can confidently go cardless, do you think?

However, that is not my main point. With the inevitability of a guaranteed cardless payment method will have to come a big overhaul in the design of most cash registers. Whether it's a supermarket, retail outlet, restaurant

or even airport, many places still require you to hand over your card to the assistant for them to scan or tap, as the scanner is not within arm's reach for the customer. Many 'tap and go' places have the pad facing towards the customer – which is great – but I've lost track of how many times I've had to hand over my phone to a cash register assistant at retail outlets for them to scan my digital rewards card, and half the time, their scanners don't work, so they have to manually enter the number! Also, with Apple Pay, it has to be your finger on the button to enable the payment, which results in a lot of awkward leaning over the counter. When boarding domestic flights in Australia, while we may have a digital boarding pass, we still have to hand over our phones to a boarding assistant for them to scan. Yes, there are security reasons for having officers at the gate, but surely people are quite capable of scanning their own phones. When will these places redesign their cash registers and scanners in response to the digital trend?

Another issue that has crossed my mind in relation to this revolves around what would happen should the

sales assistant drop your phone and damage it? If, in the process of scanning your phone at the airport, for instance, the boarding assistant drops the phone and maybe smashes the screen, is that your fault for trying to be too clever and using a digital passport, or can you claim the repairs back on compensation? Also, what happens if dropping your phone causes the screen to be unusable? How can you then access your e-ticket and prove that you've bought a seat on that flight? This is why, despite the fact I request an e-ticket while buying, if I have the time, I will always self-check-in at the airport and get myself a physical printed ticket. After all, why would I want to hand over my expensive phone (worth more than the ticket I bought) to give to an assistant when I can simply whip out my boarding pass for them to drop to their heart's content?

There are, then, many questions still without answers at this relatively early stage of converting to a cashless and future-cardless society. So while I have Apple Pay enabled on my iPhone and Watch, I will still never leave the house without my wallet!

■ Matt Prescott

APCMAG@FUTURENET.COM

Come on, have your say!

We want to hear what you think. Add to these discussions or email your views (in fewer than 250 words) to apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

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» END USER

"FTTN connections — which typically use existing copper phone wiring from a neighbourhood 'node' to the customer's premises, rather than connecting to their dwelling directly — will not likely exceed an average of around 68Mbps."



Australia's communications dystopia

With things coming to a head regarding NBN speeds, Shaun Prescott wonders: will other providers join Telstra in giving out refunds?

Got NBN? Most will answer "No", but for those who have been graced with the infrastructure, there's a fair chance you're not be happy with it. Murmurs have circulated for quite some time now, usually in online discussion boards, but now the issue of speeds has come to head: Telstra has offered to refund nearly 8,000 NBN customers whose connections fail to meet the advertised specs.

It's a pretty common olive branch: if you're not getting what you paid for, then one can only expect recompense. But it shines a light on an NBN situation which, while always fraught, is getting even more tangled. Remember all that discussion on whether fibre to the node (FTTN) or fibre to the premises (FTTP) should be used? Well, as many expected, the hybrid approach settled upon has lead to some wildly differing results and has thus proven a headache — for both the end user and providers.

Those lucky enough to have NBN coverage will likely have chosen

between four speed tiers, ranging from 12Mbps through to 100Mbps. Resellers have sometimes been advertising these as the 'maximum possible speed' rather than the speed you can expect day in, day out. And that's the rub: because a provider advertises these rates as a kind of artificial limitation, based on what you pay, it doesn't take into account what a connection can feasibly achieve depending on whether it's FTTP, FTTN or some other hybrid connection.

NBN boss Bill Morrow told The New Daily last month that FTTN connections — which typically use existing copper phone wiring from a neighbourhood 'node' to the customer's premises, rather than connecting to their dwelling directly — will not likely exceed an average of around 68Mbps. "FTTN by itself, with the copper loop lengths that we are building with, will not give you gigabit speeds," he said.

If you're told you can achieve 100Mbps on a FTTN connection, sadly, you're being fibbed to. And this is what has prompted Telstra to offer refunds.

At the time of writing, Optus hasn't yet offered to do the same.

The problem was highlighted in a recent report by the Australian Communications Consumer Action Network. "We often hear from consumers who are disconnected or have unusable services for long periods of time," the organisation's chief executive Teresa Corbin told Choice. "Consumers need to be given clear information about who is responsible for fixing faults, and NBN and the telcos must act quickly to rectify issues when they arise."

Whatever the case, if you're on a '100Mbps' FTTN connection and want to reach the speeds that you've been promised, your only real option is to pay for an FTTP connection to your premises out of your own pocket. And the cost of such an installation can range from anywhere between \$1,000 to hundreds of thousands of dollars. So welcome to Australia's 'modern communications' dystopia, everyone... ■

END USER

Share your stories!

If you have an interesting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.



GAMING LAPTOP

FROM \$2,799 | WWW.RAZERZONE.COM

Razer Blade (2017)

Is this middle-child in Razer's laptop family 'just right', or does sleekness come at too great a cost?

It's hard to believe that Razer's Blade line of portable gaming laptops only launched back in 2013, with this main 14-inch model now in its sixth hardware refresh. What's also a bit perplexing is that no other company has managed to match Razer's premium unibody design, which makes the Blades about as close to a 'gaming MacBook' as you'll find. The build quality is undeniable, with first-rate trackpad and keyboard and a chassis that can take a lot of punishment.

This unit is the 'just right' sibling in the Blade family – it's bigger and more powerful than the 12.5-inch Blade Stealth (thanks mostly to it having a dedicated Nvidia GPU, the GeForce GTX 1060), but it's not as huge or pricey as the 17.3-inch Blade Pro, which packs a GTX 1080 and starts at \$5,899. Down Under, with the top-end option costing a bracing \$7,299.

Razer doesn't offer a heap of customisability in the

2017 Blade, opting for just a single high-end CPU/RAM config (a speedy quad-core i7-7700HQ paired with 16GB DDR4), with either a glossy 4K-touchscreen or a matte-finish 1080p (non-touch) display, as well as three choices for SSD size (256GB, 512GB or 1TB). We tested the bottom 1080p/256GB model, which goes for a fairly reasonable \$2,799.

Those specs ultimately get you a very good all-rounder that can tackle any task you'd need, including playing most games at Ultra detail settings, as well as editing high-res images and video. It's also relatively sedate when it comes to gaming bling – the only marginally offensive element is the rainbow-backlit keyboard, which by default is set to a seizure-inducing, fast moving colour spectrum wave. You need to sign into Razer's Synapse software to change that, but once done, this is about as innocuous as dedicated gaming laptops come.

The matte-black unibody aluminium chassis is, as always, as tough as a pair of steel-capped boots, although there are a couple of areas where the Blade design is looking a bit dated. The 14-inch display's bezels, for example, are quite wide at about an inch on all sides, making them gargantuan next to the 5mm ones on Gigabyte's Aero 15, opposite.

While we're comparing, Razer's slightly slimmer design (17.9mm vs 19.4mm) means its cooling system isn't quite as efficient as the Gigabyte's, with the Blade's GPU get about 10°C hotter while gaming, reaching a peak of 90°C. The conductive nature of the Blade's all-metal chassis means that heat spreads out and warms up the palm-rest area – though, thankfully, that's only to a comfortable 'kitten on your lap' level.

This unit got moderately loud when gaming. While the fans can take 5–10 minutes to really ramp up, once they kick into high-gear, you'll

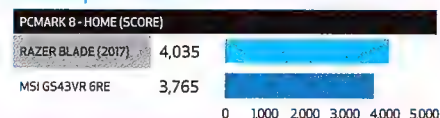
clearly hear them if you're in the same room, so grab some headphones if you're gaming. Mercifully, the Blade's pretty quick to switch those fans off when you're not gaming.

The overall value here isn't quite as impressive as on other gaming laptops around this price, as you get less storage and fewer expansion ports. So you're paying extra for the Razer brand name and the Blade family's high-quality components, although as this one's thermal numbers show, even quality parts don't always stand up well in the face of cold hard physics.

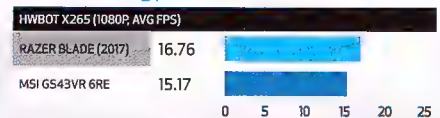
■ Dan Gardiner

LABS BENCHMARK RESULTS

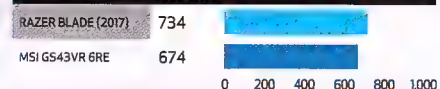
General performance



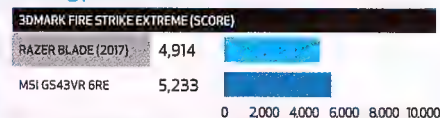
Media-encoding performance



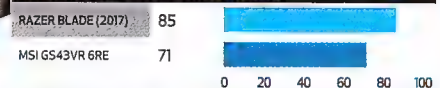
CINEBENCH - MULTI-THREADED CPU



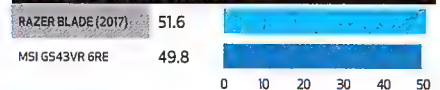
Gaming performance



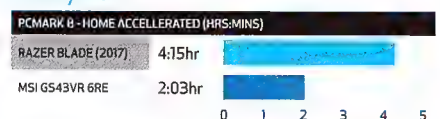
BATMAN: ARKHAM KNIGHT - HIGH 1080P (AVG FPS)



THE DIVISION - ULTRA 1080P (AVG FPS)



Battery life

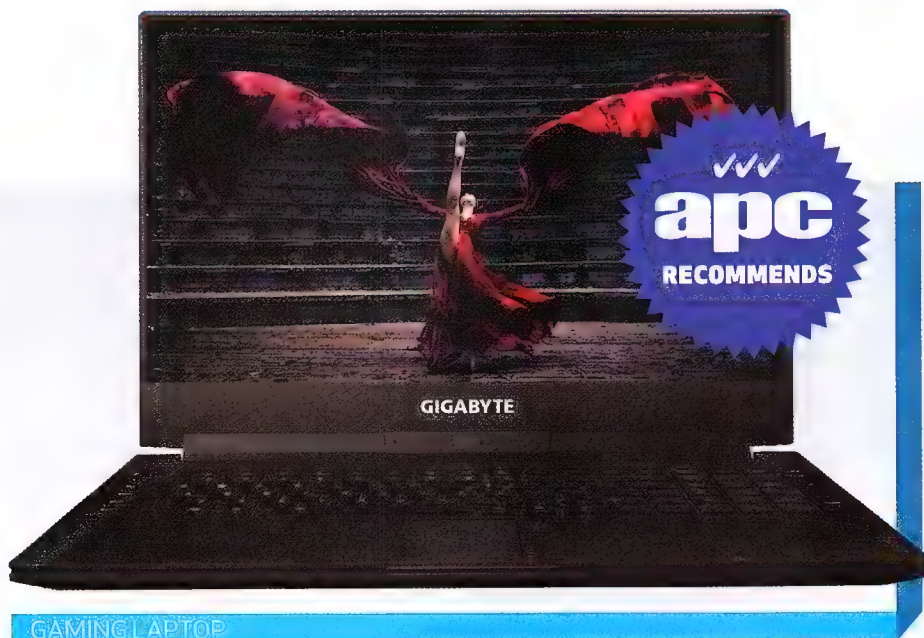


Verdict



Combining 'thin' and 'gaming' means sacrifices, but the Blade still maintains an appealing, high build-quality.





GAMING LAPTOP

\$2,899 | WWW.GIGABYTE.COM.AU

Gigabyte Aero 15

Takes the same core components as the Blade, but ends up with a surprisingly different result.

A quick glance at the Aero 15 laptop's spec sheet will tell you that it shares a lot in common with the Razer Blade, opposite — both are slim, high-performance machines built around the same core components of Intel Core i7-7700HQ CPU, 16GB DDR4 RAM, GeForce GTX 1060 GPU and NVMe SSD.

To use yet another Star Wars analogy (sorry, APC's writers seem to have gone a bit overboard this issue), this is a case of an X-Wing versus a TIE Fighter — or the designers versus the engineers, if you'd prefer. Because while this Gigabyte machine might not be quite as sleek as the Razer, it packs in more features and is arguably better value.

The key point of difference between the two is the Aero's screen. It's nearly bezel-less, with just a 5mm border on the top and sides, something that's allowed Gigabyte to squeeze a 15.6-inch panel into what's

basically the body of a 14-inch laptop. That panel comes factory-calibrated for design work — it's 'X-Rite Pantone' certified, meaning it's been adjusted to be as accurate as possible for "project-to-print" work. And despite just being a VA-based display (rather than IPS), we found the Aero's colours were richer, deeper and more natural than on the Razer's IPS panel. The bigger display does make this unit more enjoyable to game on, too.

The Aero's ports make it a bit more flexible, with an HDMI, three USB 3.0 Type-A, a USB 3.1 Type-C, Gigabit Ethernet, a Thunderbolt 3/mini-DP combo and an SD card reader. It also doubles the storage over the Blade, with a newer (and faster) 512GB Samsung NVMe SSD.

Given the slim chassis, the Aero 15 does a passably good job of keeping that heat under control, with large vents on the bottom for drawing in cooler air which is then ejected out the

back of the unit and over the screen, something which kept its GPU around 10% cooler in game testing. Fan noise wasn't quite as loud, but, again, anyone in the same room is going to know when you're gaming.

On the whole, the Aero's design is a bit more rough-and-tumble in parts, then — it's more concerned with getting the job done than looking super flash. It has a bigger footprint than the Blade, adding a couple of centimetres on the back and one width-wise and it's also 15% heavier at 2.13kg (vs 1.86kg). The chassis, too, is a mixed affair, combining CNC-milled aluminium (the keyboard deck and screen frame) with plastic (the lid and underside). While quite handsome, it's nowhere near as solid or reassuring as the Blade's unibody design.

The Aero doesn't always win on the practicality front either. That 15.6-inch screen draws more power than the Blade's 14-inch, so even with a 30% bigger battery

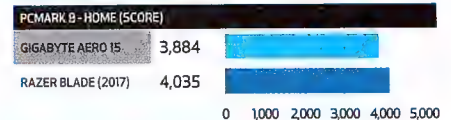
the Aero lasted only 3:22hr vs the Blade's 4:15hr in the demanding PCMark 8 Home battery life test.

Also annoying is the placement of the Aero's webcam below the screen, just above the hinge. If you do a lot of video chats (and you care about how you look in them), that'd be enough for us to suggest avoiding this one.

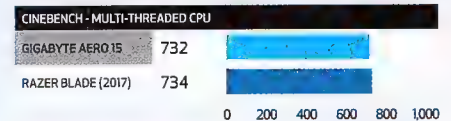
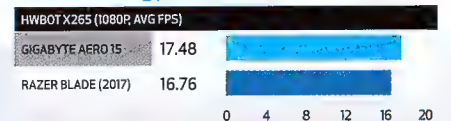
If you're trying to choose between these two laptops, it's a question of whether you value a bigger, better screen and extra ports, over a sleeker, tougher chassis and longer battery life. It's a tough call. ■ Dan Gardiner

LABS BENCHMARK RESULTS

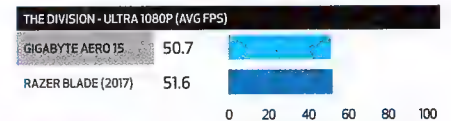
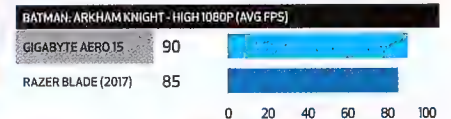
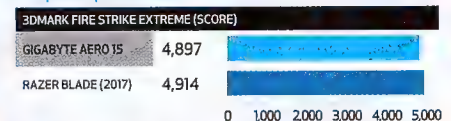
General performance



Media-encoding performance



Graphics performance



Battery life



Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

A solid workhorse of a laptop that squeezes a lot of useful features into a surprisingly small frame.



From the front, the dock is fairly unassuming, and the 'top' with the Samsung logo actually slides forward into a horizontal position, covering the insides and keeping the USB-C plug clean of dust and dirt.



Round back, the DeX Station has two USB 2.0 sockets for plugging in peripherals or storage, HDMI video output and optional Fast Ethernet and USB-C power inputs.

SMARTPHONE ACCESSORY

\$199 | WWW.SAMSUNG.COM/AU

Samsung DeX Station

Samsung's DeX Station promises to let you use your Galaxy S8 as if it were a desktop computer. So does it actually work — and would you actually want it to?

There's a dream that predates the smartphone revolution by at least a few decades: the idea that, one day, we'll all be able to have just one little digital device that caters to all our computing needs. However, it's taken the rise of smartphones over the last decade for that dream to realistically seem within our grasp.

We've seen a few attempts at bringing this concept to life, often from smaller vendors, although HP's even having a crack with its Windows Mobile-based Elite x3 handset. With the DeX Station, Samsung is perhaps the highest-profile company to try the idea yet. DeX is essentially a palm-sized pod that you can plug a mouse, keyboard and monitor into, and then plonk your Galaxy S8 (or S8+) into the cradle on top, with the video image thereafter output to the monitor and the whole setup

able to be used as if it were a desktop PC.

Now, there are some obvious limitations to this right off the bat — it's hardly convenient to be carrying around a keyboard, mouse and monitor with you, but the dock itself is small enough that business travellers could combine it with a small keyboard-and-trackpad combo unit and then plug into a hotel-room TV while they're on the road. Theoretically, the same could go for home-based users who don't have overly taxing computing needs.

So if your needs are basic, can an Android phone really replace your desktop?

DEX IN USE

Once you've got the dock all plugged in, using DeX is pretty much seamless. 'DeX mode' support is already baked into the S8 and S8+, so all you need to do to start using it is plug your phone into the dock, tap the

'Switch to Dex Mode' button that pops up on screen, then wait around five seconds for the mode change to initialise. After this first time, the S8 automatically switches to DeX mode when plugged in.

On your monitor, you get what looks like a fairly typical and intuitive Windows (or Linux) desktop computing interface — a taskbar down the bottom with an area for status icons to the right. This bottom bar works pretty much the same as the Windows' one, containing icons for all your running apps and, in place of the Start button, you've got the typical Android buttons for Home, Recents and Apps. Click on Apps and you have a searchable list of everything installed on your phone, so you can quickly start typing an app's name to find and launch it. The Home button minimises everything on screen and the Recents button gives

you eight onscreen tiles for quick switching to any of your running apps.

Android actually has keyboard and mouse support built in, so here, they work exactly as they do on a desktop computer — and they're thankfully nice and responsive, too.

Phone notifications live down in the bottom right of the display, with individual alerts popping up in small boxes as they arrive, and you can click a small arrow icon to bring up the full list. These are quite nifty, although with the ability to multitask on a full-sized monitor, they're not quite as essential as they are on a phone.

You can even make and take phone calls in docked mode. The 'phone' app runs in its own small window and voice and audio are routed to speakerphone.

APP SUPPORT

What'll make or break DeX

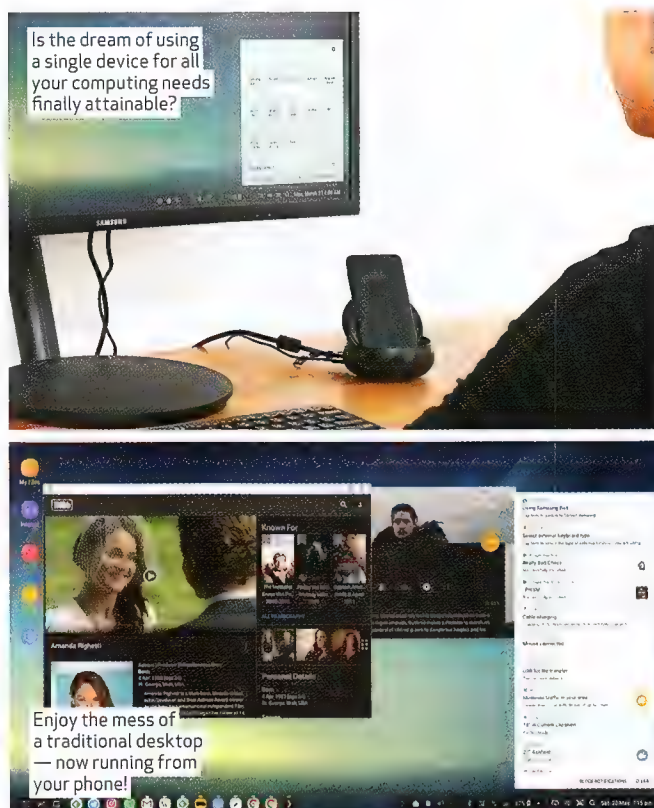
for most people, however, is app support – specifically, whether the ones you want to use are actually coded properly to be used in DeX's desktop mode. With respect to the latter, we found that Android apps fall into two general categories – apps designed for phones only and which are displayed in fixed, phone-sized windows (that you can swivel into either portrait or landscape modes), and apps that are properly responsive and can have their windows resized and rescaled, just like regular desktop ones.

You can comfortably fit about four phone-sized apps in portrait mode across a standard 1080p display, and using them this way is identical to how you would on a phone, albeit with some pros and cons from using a mouse-and-keyboard vs a fingertip and swipes.

Which apps work in which mode isn't entirely predictable. Chrome, for example, works great in desktop mode – it's almost indistinguishable from its full-fat PC counterpart, with tabs running across the top and even support for multiple windows – although you can't install any kind of extensions or add-ons.

Likewise, Microsoft's Office apps (Word, Excel and PowerPoint come pre-installed on both S8 models) also work remarkably well in DeX mode, right down to having heavily button-laden interfaces. The tie-in with Microsoft's OneDrive cloud storage service means that it's easy to switch between devices; however, you do need a paid Office 365 subscription in order to edit any of your documents or spreadsheets.

Google's Drive (nee Docs) suite of productivity apps are conversely (and perplexingly) more miss – the Android versions don't correctly scale for large-screen device use, meaning you're essentially running the smartphone versions here. While you can resize Drive apps and maximise them so they run at fullscreen, it's impossible to ignore that these are still



"We found that our regular selection of Android apps was split roughly 50/50 as to whether they worked or not"

massively cut-back mobile versions. The Sheets interface, for example, is so comically over-sized as to be useless, and you get a very lite version of Docs (sans most toolbars and buttons). You're far better off resorting to opening Drive apps in Chrome instead.

While this will vary from person to person, we found that our regular selection of Android apps was split roughly 50/50 as to whether they worked or not. The Google Play Store and Samsung's core productivity apps (Gallery, Email, Internet and My Files) all let you resize them, as does Gmail and ABC iView. Our favourite newsreading app Feedly would only run in phone mode, however,

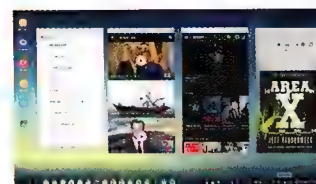
Also worthy of note is that starting or stopping DeX will see most apps close and reopen with the change of mode – you need to make sure you've saved anything you're working on to avoid data loss, although with cloud-based services this is usually automatic.

PERFECT MEDIA PLAYER?

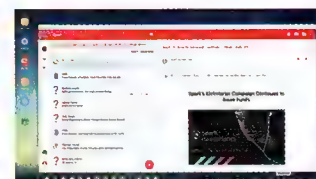
With lots of Android-based media players on the market, we thought this might be one of DeX's stronger areas, although it sadly didn't turn out that way. DeX lacks an exclusive fullscreen display mode, so there's no way to have a video just expand and fill the entire screen – the taskbar and any app window borders and controls (like the 'back', 'minimise' and 'close' that sit on each app's top bar) are always visible.

And maddeningly, a lot of video-centric apps either aren't built with responsive interfaces or didn't detect that this was an option, so they can only be used in fixed phone-sized windows. That includes Plex, our favourite media centre app that we've talked about a couple of times previously in this publication.

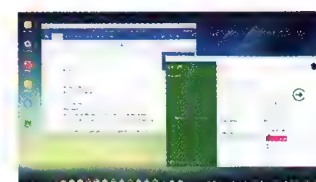
And in case it needed spelling out, it's also basically useless for gaming. Games made for fast-paced finger input (particularly swiping) do not translate



Some Android apps only work in phone mode, meaning they'll be displayed in small, fixed-size windows that can be flipped between portrait and landscape modes.



Gmail is one of the better-implemented Google apps for DeX – Docs and Sheets are another story, however.



Microsoft's Office apps work particularly well with DeX.

well to being controlled with a mouse and keyboard.

WHO'S IT FOR?

DeX is far from perfect, then – although a lot of that actually comes down to third-party Android apps, rather than being anything to do with Samsung's implementation. If your computing needs are simple – web browsing, email, office docs and so on – this could certainly replace a regular PC, but there are many caveats, and ones that you might not discover until you've tested the device with your own range of apps.

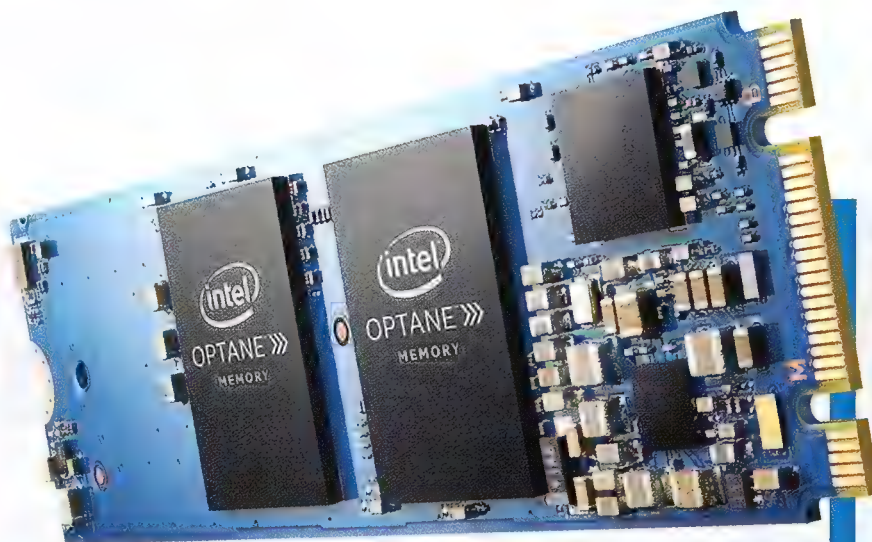
■ Dan Gardiner

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

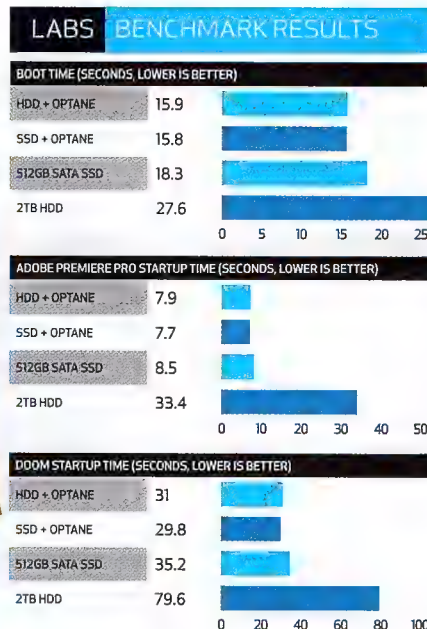
Could work as a desktop PC replacement if your needs are simple, but lack of support from certain apps holds it back.





HYBRID CACHING DEVICE

\$129 | WWW.INTEL.COM.AU



Intel Optane M.2 32GB PCIe 3.0 x2 NVMe Cache

Reinventing SSD caching, but only for Kaby Lake.

In April, Intel launched its first SSD with 3D XPoint Technology, the Optane SSD DC P4800X. Boasting incredible performance at low queue depths with high endurance, it's targeted at enterprise users. The PCIe interface is likely a bottleneck to the P4800X's performance, and Intel has a different plan for the consumer market: Optane Memory. The M.2 form factor drives offer a new alternative to Intel's ageing Smart Response Technology (SRT) and its 20/24GB SLC SSD caching drives from 2011/2012.

Capacity is limited to 16GB or 32GB. You could RAID several drives to get more capacity, but even four would only deliver 128GB – not to mention being priced about the same as high performance NVMe drives. Intel's intent is for budget and mainstream users with plain old hard drives to

upgrade to "near-SSD" levels of performance.

Setup is simple: open your PC, install the Optane Memory module and power up. Then install the Intel Optane Memory app and enable Optane Memory support. This takes a few minutes and modifies your PC to boot from the Optane module, along with copying some Windows files. Optane only provides an SSD cache for the C drive.

The problem with SSD caching is that it requires having the data you're accessing in the cache before it helps, so the first time you use an app, it feels like you're going to a hard drive. But as the system learns your usage patterns, critical and commonly used files end up in the cache, and improve responsiveness. Intel's SRT was rather underwhelming, but the faster M.2 x4 PCIe connection and low latency 3D XPoint do help.

In a few instances, the 32GB module is several times faster than a pure hard drive solution. Optane Memory is also intelligent about what files it caches, so movies don't need to consume precious space.

There's only so much a finite cache can do, of course, so if you regularly access apps that exceed its capacity, performance falls back to HDD levels. We found actively switching between four games was enough to exceed capacity – not great for benchmarks but fine for the average user.

Beating a hard drive isn't difficult, so we grabbed a budget 480GB SATA SSD for comparison. It costs about the same as a 2TB HDD plus the 32GB Optane module. The performance ties the Optane solution on the tests we ran.

More importantly, performance is always high, as there's no cache to populate. Optane can also

help performance if combined with a SATA SSD.

The biggest concern is that Optane Memory is limited to a very narrow use case. It requires an Intel 200 series chipset motherboard that supports the feature, and a Core i3 or better Kaby Lake CPU. So the only people who can use it are running Intel's latest and greatest CPUs and mobos, but they'll mostly benefit if they're running hard drives, not SSDs, which we recommend against – these days your boot drive should be an SSD.

■ Jarred Walton

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

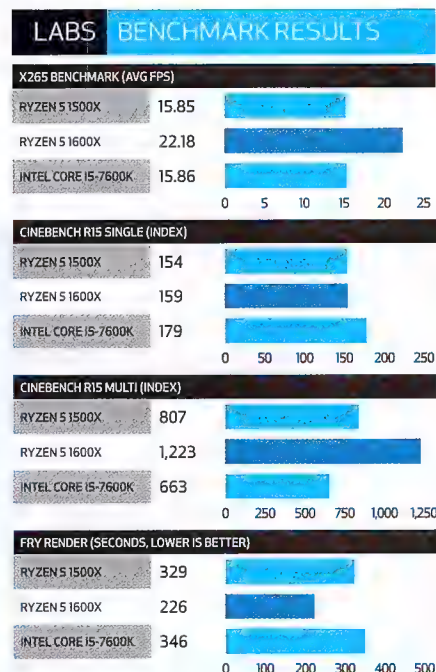
Beats a hard drive, certainly, but while it's easy to use, it's not much cheaper than a budget SSD.





AM4 PROCESSOR

\$275 | WWW.AMD.COM



AMD Ryzen 5 1500X

Can Ryzen maintain the magic with just four cores?

More cores, threads and performance for less money. That's the killer proposition for AMD's new Ryzen CPU. Suddenly, most of Intel's desktop processor range looks overpriced and short on punch.

But does that thinking extend to this, the new Ryzen 5 1500X, with its mere four cores and eight threads? After all, Intel has plenty of mainstream quad-core chips, and as good as Ryzen undoubtedly is, Intel still has the edge on a per-core basis.

Initially, the 1500X looks competitive, if not quite the knockout option of the six- and eight-core models. At \$275, it lines up roughly against the Intel Core i5-7400. That's a quad-core, quad-thread model, with a 3GHz base clock and 3.5GHz Turbo speed. Ryzen chips aren't directly comparable in terms of clock speed, but with a 3.5GHz base clock and 3.7GHz turbo speed, the 1500X has a little extra in

hand to offset Ryzen's per-clock deficiency — it's fully unlocked, theoretically allowing for even more frequency advantage where Intel keeps most of its chips locked down.

Of course, you could argue that, if you're going with Intel, you'd be crazy not to grab the Core i5-7500 for just \$10 more, what with its 3.4GHz base clock and 3.8GHz Turbo speed. And it's that kind of calculation that eventually undoes the 1500X.

Let's have a sniff around the 1500X's prowess in our performance benchmarks. Like the other Ryzen chips we've sampled, multi-threading is where it hits hardest. At over 800 points in Cinebench, it batters the much more expensive Intel Core i5-7600K. The 1500X is quicker than the 7600K in Fry Render, too, albeit by a pretty small margin, though it's more or less a dead heat in x265 video encoding. In other words, it'll absolutely beat those price-parity Core i5-7400 and 7500

processors in anything that's multithreaded.

The exception is gaming. Many titles tend to be GPU-limited at the resolutions gamers are likely to be using. But where a game is CPU-limited, Intel chips still have the edge, though it's worth noting that this quad-core Ryzen delivers the same frame rate in *Total War: Attila* as the six-core 1600X. Over time, as game developers get their heads around AMD's new Zen architecture, the gap may narrow. For now, though, gaming is Ryzen's one obvious weakness.

Nearly everywhere else, however, Ryzen is damn quick. The 1500X also impressed, in relative terms, in our overclocking tests. We managed a straight-forward and stable 4.1GHz, or a 400MHz overclock, a useful 10% boost.

So the question is: does the 1500X have enough gusto to make it a good budget option, or is it worth stretching a little further to the 1600 or 1600X? With

the latter, you're getting 50% more cores and slightly faster clocks. What's more, with any Ryzen processor, you're almost certainly going to need a new motherboard and RAM. That means an investment in the region of \$600. In that context, an extra \$30–\$75 for a lot more performance is surely the better choice.

A few years down the road, when some of us have existing systems with AMD's new AM4 socket, the value calculation will look different. But for now, and considering the total cost of going with a new Ryzen rig, this particular 1500X chip is a hard sell. ■ **Jeremy Laird**

Verdict

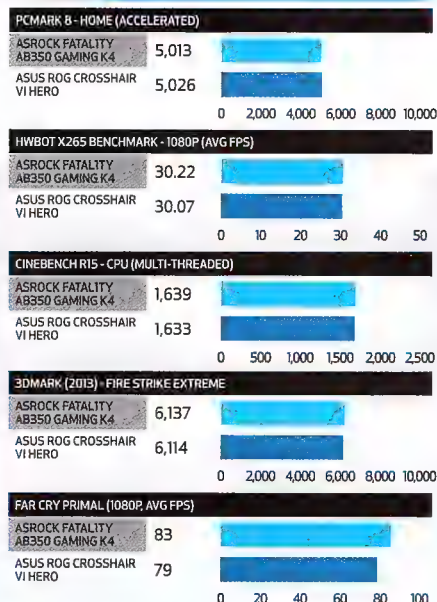
Features ★★★★★
Performance ★★★★★
Value ★★★★★

The value proposition is what pulls the rug out from under the 1500X, not Intel's alternative option.





LABS BENCHMARK RESULTS



AMD MOTHERBOARD

\$159 | WWW.ASROCK.COM

ASRock Fatal1ty AB350 Gaming K4

Impressive performance with value-orientated positioning.

ASRock has delivered a mighty motherboard in the shape of the Fatal1ty AB350 Gaming K4. With a well-appointed set of features and at a very approachable \$159, it undercuts the cheapest B350 boards we saw from Gigabyte and MSI in our May issue round-up by \$20, and proves a shining example of both ASRock's ability to select just the right specs and the power of the AMD B350 chipset.

Testing using our high-end Ryzen setup (a Ryzen 7 1800X, 16GB of DDR4-2666 RAM, an Nvidia GTX 1080 Ti FE and Crucial MX300 SATA and Samsung 960 Evo NVMe SSDs), the K4 returned results that were stronger than we expected. In fact, on numerous occasions, this fearsome little 'board took on the AM4 king – ASUS's RoG Crosshair VI Hero (see the May issue). And while we still prefer the \$370 Hero

overall, there's no denying the capability demonstrated by the K4 at this massively lower price.

There's a range of caveats involved in hitting that wallet-friendly mark, however; including the use of a Realtek RTL8111GR NIC to facilitate LAN, rather than the more well-regarded Intel I211-AT (usually found on more expensive boards); or the use of a low-end Realtek ALC892 audio chip instead of the higher-end ALC1220, not to mention this board's lack of USB 3.1 support. But for many, these 'alternate' component selections are going to be peripheral to just having a fast and stable system, and in those cases, many will be quite happily satisfied by this offering.

Aesthetically, the K4 will likely polarise opinions. The strong red-and-black theme may be considered a little tired by some, and the disruption this creates when

considering RGB lighting integration into a system build. Additionally, the PCB inking associated with the M.2 slots may render a take-it-or-leave-it approach.

Colour coordination aside, the visual design of the thermal solutions – VRM and PCH heatsinks – is of a nice minimalist style and doesn't command too much attention beyond the colouring. If red and black are your thing, this board looks the piece.

In our benchmarks, the AB350 Gaming K4 demonstrated its gaming chops with strong results in both the 3DMark synthetic tests and the real world results, such as *Far Cry Primal*. That said, X370-chipset based boards still have an edge up on these B350s when it comes to CPU-based workloads, as you can see from the the PCMark 8, HWBot X265 and Cinebench R15 benchmarks. However, in storage the K4

was neck and neck with ASUS's Crosshair VI Hero.

The value presented by the ASRock Fatal1ty AB350 Gaming K4 is still very impressive on the whole, however, and we'd happily recommend this one for Ryzen builders who are seeking a capable AMD motherboard with reasonable specifications and impressive performance – and which doesn't get anywhere near breaking the bank. Very capable at a very keen price.

Josh Collins

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Impressive performance, a reasonable yet capable spec and well priced. For the price conscious AM4 buyer.





INTEL MOTHERBOARD

\$269 | WWW.GIGABYTE.COM.AU

Gigabyte Z270N-Gaming 5

Mini size with maximum performance.

There was once a time when opting for a small motherboard – specifically mini-ITX – meant making significant compromises. Thankfully, that's no longer the case and the mini motherboard masters have continued to add features to such a degree that they've made fully-fledged ATX boards irrelevant in the eyes of many. The Z270N-Gaming 5 is great example of that push – this is a mini-ITX motherboard built for speed but that still ticks as many boxes as possible for its diminutive form.

The Z270N-Gaming brings a slew of component-level features to the table. Starting with the somewhat standard Intel I219-V LAN NIC found on many Intel Z270 'boards and Realtek ALC1220 high-definition audio codec, the board also features an integrated Intel dual-band Wireless-AC 8265 NIC via an M.2 slot to provide the motherboard with 2T2R 802.11ac Wi-Fi

networking mounted to the rear I/O. This addition means gaming via a wired Ethernet cable or AC wireless solution is open for selection.

Sporting the nearly ubiquitous mini-ITX setup of four SATA 6Gbps ports for mass storage and two DIMM slots (with support for a maximum of 32GB of RAM in a 2 x 16GB configuration), the Z270N-Gaming 5 has enough in both areas that many enthusiasts will be catered for – those wanting more will have to move to a larger form factor. Add to the mix a rear-mounted M.2 slot with support for Z260 and Z280 form factor M.2 NVMe SSDs, plus headers to support USB 2.0 and 3.0 outputs for front panel connections and plenty of onboard I/O potential.

Moving to the rear I/O, there's again a good array of options that'll cater to the needs of the average user. With four USB 3.0 ports, plus two USB 3.1 pots (Type-A and C), owners will perhaps need to be mindful of their USB port allocation and

usage – an external powered USB hub may be needed for those with more than six USB devices. The audio I/O is served by the typical three 3.5mm jacks. While technically the platform can support 5.1 and 7.1 surround sound output, this is requires the use of a combination of rear I/O and front panel connectivity – hardly convenient. If surround sound is your focus, perhaps consider another 'board with a six-stack audio I/O solution for easier setup and tidier cabling.

When it comes to looks, the Z270N-Gaming 5's orange theme is going to be a love or hate aspect. Though some may say it ties into the Aorus motif (though this isn't an Aorus-branded product), the heritage of this little 'board is actually in-line with the Super Overclock (SOC) series and, indeed, Gigabyte informed us that the Z270N was set to join the SOC family during the product's development and it was only towards

launch that it was given the 'Gaming 5' designation. Many SOC fans have since learned (as have we), however, that this little fighter still offers performance in spades. Though we had issues with getting our DDR4-3200 spec RAM to run at the DDR4-3000 standard we typically use for Z270 testing, even using the slightly lower DDR4-2933 setting for returned speedy results, the Z270N-Gaming 5 had no troubles running the DDR4-3200 XMP profile on our RAM kit.

All considered, then, this is a little 'board that really delivers. ■ Josh Collins

LABS BENCHMARK RESULTS

PCMARK 8 - HOME (ACCELERATED)

GIGABYTE Z270N-GAMING 5	5,023
GIGABYTE AORUS Z270X-GAMING 8	5,548

HWBOT X265 BENCHMARK - 1080P (AVG FPS)

GIGABYTE Z270N-GAMING 5	24.24
GIGABYTE AORUS Z270X-GAMING 8	24.13

CINEBENCH R15 - CPU (MULTI-THREADED)

GIGABYTE Z270N-GAMING 5	986
GIGABYTE AORUS Z270X-GAMING 8	982

3DMARK (2013) - FIRE STRIKE EXTREME

GIGABYTE Z270N-GAMING 5	6,612
GIGABYTE AORUS Z270X-GAMING 8	6,540

PAR CRY PRIMAL (1080P, AVG FPS)

GIGABYTE Z270N-GAMING 5	61
GIGABYTE AORUS Z270X-GAMING 8	57

Verdict

Features	★★★★★
Performance	★★★★★
Value	★★★★★

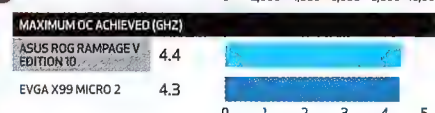
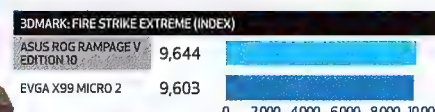
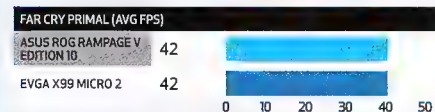
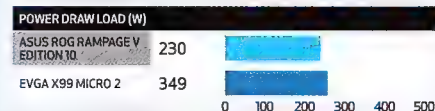
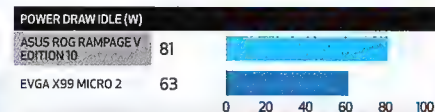
A capable pint-sized motherboard with top performance chops.





LABS BENCHMARK RESULTS

General performance



INTEL MOTHERBOARD

\$880 | WWW.ASUS.COM/AU

ASUS RoG Rampage V Edition 10

The best ASUS has to offer.

It's not every day we get something as exceptional as this – a board that challenges all logic, positioned so high on the economic spectrum that only the rich kids of Instagram and those really looking to burn holes in their pockets can attest to its brilliance.

This is, without doubt, a ridiculous board. Not in the same way as ASUS's X99-E-10G workstation motherboard, but in a ludicrous concept kind of deal. It's a well established fact that gaming benefits from higher-performing single cores than slower-performing multi cores, as found in the Broadwell-E and the X99 platform. That's not to say that this dollar-burning combo is particularly bad at gaming, merely that it's unnecessary. For the purist, there's no logical reason to spend all that extra cash on an eight-core processor and above. But for the professional, the streamer, the YouTuber, the showcaser, well... that's a different story.

Let's talk about what you get for all that cash. Well, outside of the 2011-3 socket and quad-channel memory, supporting up to 3,333MHz, you also get a neat 5.25-inch DAC capable of powering even the most ambitious 600-Ohm headphones, some stellar RGB lighting (genuinely, this stuff actually looks pretty solid), wireless A/C, two Gigabit Ethernet, two USB 3.1 Type-C, two USB 3.1 Type A, four USB 3.0, two USB 2.0 and even a combi port, plus the usual assortment of 5.1 audio, TOSLink and the two neat additions of BIOS reset and clear CMOS switches in the rear.

However, it's the board itself that touts the biggest arsenal of connectivity, with no fewer than four PCIe x16 slots, a plethora of fan headers, USB 2.0 headers, RGB headers, two USB 3.0 headers, and a full bank of 10 SATA 6Gb/s, followed by Intel's now almost defunct U.2 connection standard. Plus, it looks stunning. The rear I/O cover, in particular, immediately draws your

eyes to it, especially with that slice of RGB lighting baked in.

Then there's the performance, which really pushes the boat out for the Rampage V Edition 10, particularly when it comes to overclocking. For the first time in a very long while, we managed to push our Core i7-6950X beyond the 4.3GHz limit – admittedly, only to 4.4GHz, with 1.45V in the V Core, but achieve that it did. We've seen the X99 Strix Gaming achieve similar, but it wasn't anywhere near as stable as our overclock on the Rampage V, and it took multiple attempts to get both the temperature and voltage just right.

On top of that, power consumption is equally impressive. In our power load test, we saw a total power draw of 230W from the wall, in stark contrast to the X99 Micro 2's 350W. In fact, we were so impressed that we left it running for 10 minutes, and still saw very little fluctuation in figures.

Ultimately, this motherboard is not for the

faint of heart. Its extreme price puts it out of reach of all but the most enthusiastic enthusiasts. It's ideal for liquid cooling, and those looking to build a super-clean system using the X99 platform. Combine this with one of EKWB's full cover monoblocks, and it's truly a thing of beauty.

But does it warrant the price? Only if you have access to a plethora of processors you can bin for it. For the average punter, that's simply not the reality, and you would be far better off investing in something lower down in RoG's lineup, such as the Strix X99 or even the Prime instead.

■ Zak Storey

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Stunning OC performance, clean BIOS, included DAC and awesome design, but that price...!

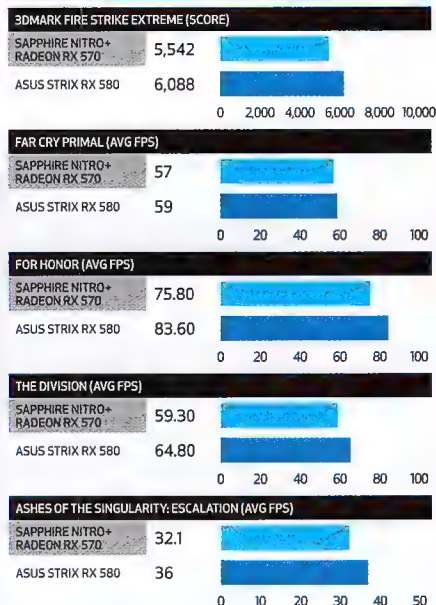




GRAPHICS CARD

\$329 | WWW.SAPPHIRETECH.COM

LABS BENCHMARK RESULTS



* ALL GAMES TESTED AT 1080P WITH THE HIGHEST DETAIL SETTINGS.

Sapphire Nitro Radeon RX 570 (4GB)

Another new Radeon that's not really 'new'.

We've found ourselves questioning whether the Sapphire Nitro RX 570 – or Radeon RX 570 GPUs in general – represents a worthy sequel to the RX 470. In other words, is this *The Empire Strikes Back* or *The Phantom Menace*? Unlike in the movies, however, that ultimately turned out to be a tough question to answer, and will largely depend on how you feel about the practice of rebranding GPUs.

The Radeon RX 580 is the RX 570's sibling – which is found at the heart of this Sapphire card – and is also a rebranded product, taking the previous-gen Radeon RX 470 and bumping up clock speeds a bit to deliver a performance increase. In the Radeon RX 570's case, however, it's thankfully a bit more than that.

Utilising a tweaked Polaris architecture built on

a refined 14nm FinFET process, the 570 can deliver reduced power consumption thanks to tweaked power management. This introduces a third 'mid-tier' power state, which sits between the maximum and minimum memory power states available on the 470. That should provide more efficient power use in scenarios associated with multi-monitor setups, multimedia playback and when systems are idle.

Also brought to the table with the RX 500 series is the new 'Radeon Chill' feature, which aims to be an innovative way to reduce GPU power consumption and create more options for energy-conscious gamers. The Chill feature can be easily enabled or disabled via AMD's driver software and has launched with a sizeable list of supported titles, including the eSports staples of *CS:GO*, *League of Legends* and *Dota 2*.

It has a couple of ways of working. The first is by effectively reducing the rate of frame processing – and therefore delivery – by the GPU when the user is in-game but in an idle-type scenario (such as, standing by in an MMO save zone with little occurring on screen), and then increasing the frame rate when the user becomes active once again. Additionally, in older games like *CS:GO*, which are easily driven by modern GPUs, Radeon Chill can cap excessively high frame rates, thereby further reducing power consumption by the GPU.

For real-world gaming assessment, we monitored performance in *Far Cry Primal* (DX11), *For Honor* (DX11) and *The Division* (DX12) at 1080p with the visual eye candy turned up. Sapphire's Nitro RX 570 delivered average frame rates just shy of the 60fps marker, the typical goal for

a smooth gaming experience for the average user.

For the price, at 1080p, the Sapphire Nitro RX 570 delivers fair performance, so if you're looking to upgrade from a GPU that's a few generations behind, this'll give you a newer feature set and won't break the bank. But it's worth remembering that the GeForce GTX 1060 is at play to in a comparable price bracket – and can even be found a little cheaper – and in many games offers fractionally better speeds.

■ Josh Collins

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Though it's undercut by the GeForce GTX 1060, if it's red or dead, the RX 570 is still a compelling mid-range GPU.





GAMING MONITOR

\$599 | WWW.AOCGAMING.COM

AOC Agon AG251FZ

A superfast TN panel aiming for 240fps gaming.

Speed matters. How do you like that for a sales pitch? If there's any truth to it, you'd think AOC's Agon AG251FZ gaming monitor is a certainty for success. After all, it clocks in with a 240Hz refresh rate.

It wasn't too long ago that LCD monitors capable of anything north of 60Hz were unusual. Now, 120Hz and even 144Hz screens look like technological chumps. But, as refresh rates creep ever higher, a conundrum slides into smoothly-rendered view. Is there a point at which increasing the refresh rate stops making a difference?

Hold that thought while we navigate the AG251FZ's main feature set. It's a 24.5-inch LCD monitor with a Full-HD 1080p native res (1,920 x 1,080 pixels). In this age of the 4K, 40-inch TV for under \$400, the AG251FZ looks painfully pricey.

That value only looks worse when you consider that it also uses low-cost TN panel technology, not the

more expensive IPS or VA alternatives. But driving the latest games at full detail, fast enough to make full use of that 240Hz refresh capability, is no small feat, even at 1080p. Up the ante to 4K or even 1440p, and the chances of achieving anything close to 240fps are outstandingly remote, even with the most powerful graphics hardware.

Similarly, given the remit is fast-paced gaming, using the fastest screen tech, even if it has shortcomings in other areas, makes sense. Add to that a number of other gaming-friendly frills, including a low-input lag mode and FreeSync support, and the result is an overall package that looks promising.

But how good is it in use? The TN panel is one of the better examples of the twisted nematic art we've seen. In fact, for colours and contrast, it's as good as we've seen from this panel type, other than the recent crop of 4K TN models, which are really in a class of their own.

It's still not a patch on the best IPS and VA screens. That's especially true if you factor in the latest models with quantum dot or HDR technology. Most obvious are the relatively narrow viewing angles. It's the one metric by which TN tech has conspicuously failed to close the gap on other LCD panels. But in isolation, this monitor puts on a decidedly decent show for basic image quality.

So what of that crazy-high refresh rate? In various synthetic tests, including text scrolling and image panning, it is just possible to discern the difference between, say, 120Hz and 240Hz. It's not nearly as obvious and dramatic as the step up from 60Hz to 120Hz, but it's there. Picking that difference out in games is a whole different story, and it's not something we could do reliably. That's not to say there are no benefits, but they are relatively subtle.

That said, the AG251FZ's other gaming features certainly add to the

package. The pixel response is about as good as it gets, and the overall experience is utterly lag-free, even without enabling low-lag mode. If you're looking for a seriously quick and slick panel for first-person shooters, the AG251FZ should certainly be on your list.

For everyone else, it's something of a niche proposition. Even for gamers, the benefits of 240Hz are probably marginal versus a 120Hz monitor. In reality, most will prefer more pixels or a higher quality panel for similar money.

■ Jeremy Laird

Verdict

Features
Performance
Value



Crazy high refresh rate and a seriously fast pixel response are balanced out by only decent image quality.



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CAT.6

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BILLION



INKJET PRINTER

\$399 | WWW.EPSON.COM.AU

Epson Expression Photo XP-960

A compact MFP that can produce highly professional results.

There are plenty of all-in-one inkjet printers on the market, but not so many that are capable of handling A3 paper. Epson's relatively affordable XP-960 takes up minimal desk space, uses an extra colour in its six ink system, can scan at 4,800dpi, and has three trays for dedicated media, making it a machine suitable for a home office or a medium-sized business.

The rounded sides of the Expression Photo XP-960 reduce physical bulk as much as possible, so while it has the capacity to handle A3 paper, it's small enough to share an average-sized desk with a computer and still have room to spare. The glossy black finish is a magnet for dust, but because all the trays and flaps automatically fold neatly away, it's very easy to wipe down with a duster. The colour display is a

generously-sized 4.3-inch touchscreen, making it quite easy to print directly from an SD card (or myriad other flash memory cards) without any need to access a computer, as well as making the setup process a breeze.

The ability to handle A3 paper is what really sets the XP-960 apart from your average all-in-one photo printer, but besides that, you have a fairly full feature set, too. Duplex printing is possible with A4 plain paper, for example, and in this mode, the print speed accelerates from 8 to 28 pages per minute.

Having two paper in-trays is an advantage, because it means you can load one with plain A4 and the other with photo paper, envelopes or printable blank CD-sized discs, and not have to empty the tray each time you switch media.

The scanner, meanwhile, can capture very high resolution scans of 4,800 x

4,800dpi, which is good news for designers who can save the scanned documents onto a USB thumb drive or a mobile device via the app – or have it emailed to a PC.

Epson's Claria Photo HD ink system uses six, instead of the usual five, colour cartridges (magenta, light magenta, cyan, light cyan, yellow and black) to achieve superior colour fidelity.

The XP-960 achieved average results after its print heads were cleaned and realigned – the print speed is a little slow at less than nine pages per minute, but text looks sharp enough. Characters lack the light touch of a laser and look a little heavy-handed, but they're perfectly acceptable for an inkjet.

Colour documents benefit from the six ink cartridge system and show good separation and consistency. When it comes to printing photos on photo paper, the XP-960 really shines.

There's no ink mixing or smearing, and a real boldness to the colour palette gives quality images that professional touch.

Thanks to its accurate six-ink cartridge system, the Expression turned out professional quality prints every time in our full colour tests. For plain text documents, this machine begins to look a little expensive to buy and run, but its wide feature set and ease of use justify the costs if you plan to do any kind of A3 printing as well.

■ Jim Hill

Verdict

Features	★★★★★
Performance	★★★★★
Value	★★★★★

A fantastic all-rounder for those that want to focus on A3 photos, but it's overkill for just day-to-day printing.



"The new Vigor 2925P is one of DrayTek's most powerful routers to date, with features rivalling some enterprise products."



BROADBAND ROUTER

\$750 | WWW.DRAYTEK.COM.AU

DrayTek Vigor2952P

A small business router with enterprise router features.

DrayTek occupies a strange place in the router pantheon. Its products tend to be targeted at a particular band of small to medium businesses and branch offices – people who need some enterprise-like features but don't need to go for the full corporate package or support hundreds of people at once. They're even designed like rack-mounts in miniature, with all ports except power up front, which makes them ugly but functional.

The new Vigor 2925P is one of DrayTek's most powerful routers to date, with features rivalling some enterprise products and without some of the (often artificial) limitations of, say, Cisco 800 series routers.

One of its most interesting features is the SFP (Small Form-factor Pluggable) WAN port, which is unusual in a router in this price range. SFP lets the router (using an SFP module) connect directly to optical networks like fibre channel, SONET and

Ethernet over fibre. DrayTek actually provides a hard Ethernet port for the same WAN port as well – but if something is plugged into both, SFP takes priority. There's also a secondary WAN Ethernet port, as well as support for USB 3G/LTE modems for additional WAN connectivity.

Even if you have no use for SFP, there's a lot to recommend the router still. Its four LAN ports support Power over Ethernet, which makes it perfect for voice applications. It has enough processing power under the hood to support 50 SSL VPN tunnels and its twin USB ports support modems, storage or printers for sharing.

There is a huge array of business routing tools available in the firmware. There is the aforementioned VPN support – though, for some reason, SSL VPNs and other VPNs retain separate setup interfaces. There are advanced bandwidth-limiting and quality of service tools, allowing fine

session control and the setting of fixed bandwidth limits. There are also sophisticated VLAN segmentation tools, as well as load balancing rules if you're using multiple WAN interfaces.

DrayTek includes content security management (CSM) tools as part of its interface, too – a set of tools that you can use to block certain web services and sites. It's somewhat similar to parental controls, but with a more corporate bend, designed to stop employees from visiting inappropriate or time-wasting sites. On top of that, there is centralised management support for switches and access points built into the interface, letting you configure multiple DrayTek devices from the single router interface.

The downside of this is that all these tools and all the configuration options available to them add up to a relatively complex interface, and one that could frankly use a bit of reorganisation

and cleaning. DrayTek does not, in general, hold your hand, although we do very much appreciate that new wizards have been added to the firmware – including wizards that make setting up LAN-to-LAN and remote access VPNs about a thousand times easier.

For its complexity, however, you're getting one of the most highly configurable routers on the market, a box that offers enterprise-level security and content management at a price and form factor more suitable for small businesses.

■ Nathan Taylor

Verdict

Features	★★★★★
Performance	★★★★★
Value	★★★★★

Great value for a true security router with Power over Ethernet and even SFP support.



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GAMING MOUSE

\$139 | WWW.CORSAIR.COM

Corsair Glaive RGB

A wolf in a mouse's clothing.

The Glaive is, as the law dictates, full of RGB LEDs. It forgoes the desktop halo in favour of a three-zone config, which lights the logo, bands on either side of the palm edge and a pair of front-mounted lights. Each zone can be configured with gradient fades, rainbow effects or flashing colours. The LEDs aren't the brightest, but that suits as they're placed in understated locations, and aren't there to shout, more to whisper your love of coloured peripherals.

The only other lights are the DPI markers, which show which of the five levels you've selected. Unusually, these aren't hard-coded into the unit, and can also be configured in the Corsair Utility Engine 2 software, which we should take a second to praise. It's easy to understand and deeply detailed. Good job, Corsair. You can also use CUE 2 to configure each of the Glaive's six buttons, and switching between layouts

is trivial. You can glide from a desktop mode to a gaming one in a couple of clicks.

The sensor is a custom-built 16,000dpi and can be software calibrated. It's beautifully weighted, and while it lacks gimmicky weights, we suspect that's because Corsair's engineers knew you'd be happy with it as it is. The palm surface is covered in a soft, almost velvety plastic coating, the kind that degrades over time, while the edges and notched wheel are clad in a textured rubber.

The panel on the left edge can be replaced, too. Pull it off, select an alternative (such as a thumb rest) and it mounts back on via magnets and an alignment groove.

This is one hell of a comfy, versatile mouse. ■ Alex Cox

Verdict

Well weighted, hugely configurable and with great software. Corsair has put a lot of thought into this.



PAYAM
Data Recovery



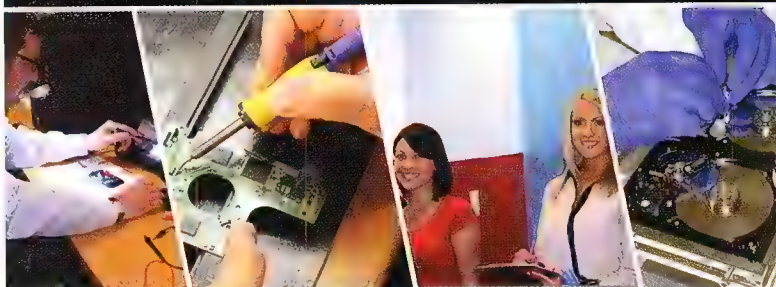
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MECHANICAL GAMING KEYBOARD

\$139.99 | WWW.LOGITECH.COM

Logitech G413 Carbon

Is this super-thin mechanical keyboard one compromise too far?

The G413 is Logitech's first affordable mechanical gaming keyboard and it ditches the usual media and macro keys, along with fully customisable RGB backlighting, in favour of a frameless design and a full set of Logitech proprietary Romer-G switches.

When compared to most gaming keyboards – or even most PC keyboards come to that – the G413 looks a little naked; as it lacks a plastic fairing, you can see the underlying base plate in all its glory. However, we do dig the painted black metal and red backlighting. Luckily, losing the external shell hasn't cost the G413 any sturdiness. You'll have a tough time finding any points of flex, thanks to its solid, aluminium-magnesium alloy plate.

The only thing some users might not love is how the key caps basically hover right above the base board without any protection on the sides. But we personally love the simpler design.

Rather than going with membrane keys or Cherry MX switches, the G413 comes with Romer-G mechanical switches, which are responsive and relatively silent, and rated for 70 million actuations. Logitech also includes a set of 12 faceted key caps that you can use to replace the WASD and first five number keys, plus a few others. And on the bottom of the board is a handy cable pathway for your headphones cable to be tidily hidden.

While the presence of USB passthrough is welcome, the fact that it's limited to USB 2.0 seems like an oversight; as does the lack of dedicated media keys. However we think both compromises are a relatively small price to pay given the G413's price. ■

Verdict

Compromised it may be, but the G413 is one of the best budget gaming keyboards around.



GAMING HEADPHONES

\$229 | WWW.HYPERXGAMING.COM

HyperX Cloud Revolver S

A sweet set of gaming cans to get your head in the clouds.

The Cloud range built itself a reputation on great sound and supreme comfort at an affordable price. But as the family grows, are the top-of-the-range cans bringing enough to the table to warrant their loftier prices?

Considering you can get the original Cloud Revolver headset for \$119, the key question here is really, "Is the addition of surround sound worth \$110?" The answer is a rather limp, "That depends." If you're playing games that have dedicated surround support, the Revolver S's sound is impressive, with a balanced, immersive sound that envelops you as you play.

However, in games that only deliver stereo output, the headset's integrated USB soundcard can muddy the acoustics when trying to deliver a virtual surround experience, although you can switch to regular stereo at will. We did find that the directionality of sound sources was obscured, and

the overall audio generally distant, with a slight echo.

Thankfully, the comfort of the original Revolver headset has carried across. The earcups and headband both have luxurious memory foam, and the latter sits on elasticised suspension to alleviate any undue weight.

The build feels sturdy, with metal elements and braided cables; however, the in-line USB soundcard feels a bit cheap and plasticky.

For just listening to music, these perform fairly well, too – the soundcard has three selectable EQ options (bass, vocal or flat) and the 50mm drivers, combined with the semi-open-back design, make for an impressive sense of space.

■ Harry Domanski

Verdict

A great headset, best for playing games with dedicated surround sound support.

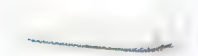




Elgato Eve Motion



Elgato Eve Energy



Elgato Eve Room



Elgato Eve Weather

HOME AUTOMATION GEAR

ROOM, \$139.95; ENERGY, WEATHER AND MOTION, \$84.95 | WWW.ELGATO.COM

Elgato Eve

An Apple-connected smart home network that has eaten from the tree of knowledge.

While most home automation systems are focusing on using a central hub to process and manage the data and interactions of its sensors, Elgato's Eve takes a different approach; distributing the processing load across each of the range's four unit types and allowing them to interact directly.

The system also relies on Bluetooth connections between units and the iOS app rather than your home router's Wi-Fi connection or a proprietary hub. This reduces the initial outlay if you want to do a specific home automation task, but a clever optional integration with Apple's second-gen TV also accommodates the off-site sensor control that you get from a traditional hub or home automation setup.

EVE ENERGY

Energy is the crux of the Eve range. Not because it carries the smarts to act as a hub,

but due to the fact this plug and power socket allows you to control anything and everything you plug into it. Energy can be turned on and off using the Bluetooth-connected iOS Eve app, but you can also create automated power routines with other Eve products. Depending on the sensors it's paired with, you can turn devices on and off based on any combination of motion, temperature, air quality and whether or not a window or door is closed. Like most of the other units, the Energy has more than one function, and also keeps track of the energy consumption of a particular socket.

EVE ROOM

As the most expensive and most complex of the Eve devices, the \$140 Wireless Indoor Sensor packs a lot of smarts into its square 7.9cm frame. As well as a digital thermometer, this compact unit includes a humidity sensor and an air quality sensor to give you a well-

rounded picture of a room's ambient conditions. As one of the only units on the market with an air quality sensor that measures both carbon dioxide levels and the number of volatile organic compounds, this clever device can be used to trigger an air conditioner, humidifier or even an air purifier.

EVE WEATHER

This wireless outdoor sensor relocates the Room's topside ventilation to the rear of the unit, in order to facilitate an IPX3 splash-proof water resistance. In addition to the necessary weatherproofing, this 3cm-thick tile replaces the air quality sensor for an air pressure gauge. We're guessing that a running hectopascal measure will be overkill for most people, but since the device keeps the temperature and humidity sensors and only requires two of the Eve Room's three batteries, it isn't really a limitation. The app stores up to 21 days of recorded data

locally on the unit and displays it to an easy-to-manage graph.

EVE MOTION

The primary function of the Motion is to use its 120° motion sensor to detect any movement within 9m. You can adjust the sensitivity threshold for recognition, and it can also trigger its own actions when paired with an Eve Energy or a compatible Apple Homekit accessory like a smart bulb. Elgato suggests that its two AA batteries and Bluetooth 4.0 Low Energy connection will see it last more than a year. ■ Joel Burgess

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

This Apple-friendly home automation network spreads the load around, and offers maybe more info than you need.



software

» APPS FOR ALL THE PLATFORMS



Windows SOFTWARE

Revo Uninstaller Free

Who cleans up the cleanup software?

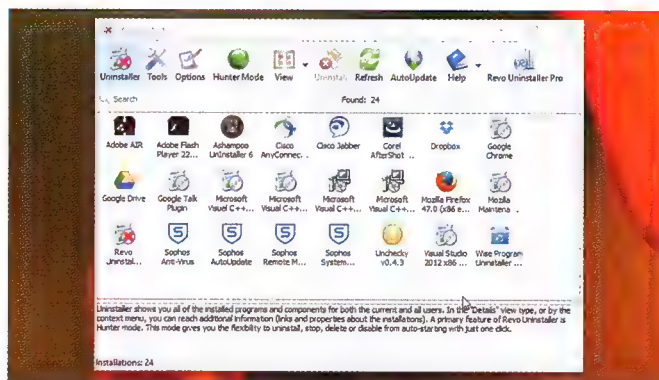
FREE | WWW.REVOUNINSTALLER.COM



Most programs come with their own uninstallers, but sometimes, these don't do a very thorough job, leaving behind temporary files, unused registry entries and other detritus. These remnants take up space on your PC, and can cause conflicts if you want to install a newer version of the same software at a later date.

Revo Uninstaller is one of a number of similar apps that scans your PC for installed programs and lets you remove every trace of them, including the bits that would normally be left behind.

The free version we've tested has several limitations when held against the premium edition (there's no way to uninstall multiple programs at once, for example, and it can't monitor system changes in real time) but that's to be expected — the free versions of competitors IObit Uninstaller and Wise Program Uninstaller don't offer those tools either. Revo Uninstaller Free has a simple interface — just select a



program from the list and click 'Uninstall' to remove it. The software will create a System Restore Point before it begins, which is reassuring. The program's uninstaller will run as normal, after which, you'll be offered three scanning options to look for mucky footprints left by the departed software — safe, moderate and advanced.

Revo Uninstaller Free also includes links to Windows' own system maintenance tools (including defrag and task scheduler), tools for removing temporary browser and Microsoft Office files, and the conspiratorially named 'Evidence Remover' (a file shredder).

If you just need to remove one particularly stubborn program, you might like to try installing the free trial of the Pro version and using the powerful Force Uninstall option.

Revo Uninstaller Free is a perfectly good software uninstaller, though the Pro edition is vastly superior, and its extra tools are a strange bunch.

Cat Ellis

PhraseExpress

Save time on tedious typing.

FREE (PERSONAL USE) | WWW.PHRASEEXPRESS.COM



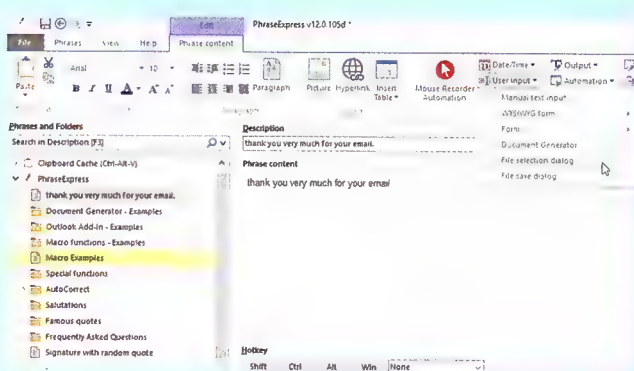
PhraseExpress works as a universal autocomplete tool, saving you time and effort by inserting commonly used phrases and other text into any program when you type a particular shortcut.

You can also use it to complete forms automatically, and to create macros that automate repetitive tasks.

PhraseExpress has dozens of possible uses: you can enter whole boilerplate emails with just a few keypresses, choose from a list of email signatures, complete forms and write letters using ready-made chunks of text.

It's basically designed to make your life as simple as possible: let it run in the background and it'll learn phrases or chunks of text that you use frequently, and suggest continuations when you begin to type them — like predictive texting on your phone, but much more accurate and for far larger sections of text. Its can work systemwide too — for websites, as well as software — or you can restrict it to certain applications if you prefer.

The main program window lets you manage your phrases (including those created automatically or manually), assign



shortcuts (with optional hotkeys), and import and export phrases — ideal if you use multiple PCs and want to share settings across them.

PhraseExpress's macro creation tool is particularly impressive, recording your mouse actions and reproducing them on command. You can also create autotext that will open a certain program, file, directory or webpage instantly.

This can be an amazing timesaver for anyone who frequently finds themselves typing the same text. Cat Ellis



Mosaic

More ways to work with your Mac's windows.

STANDARD VERSION: \$18 | LIGHTPILLAR.COM



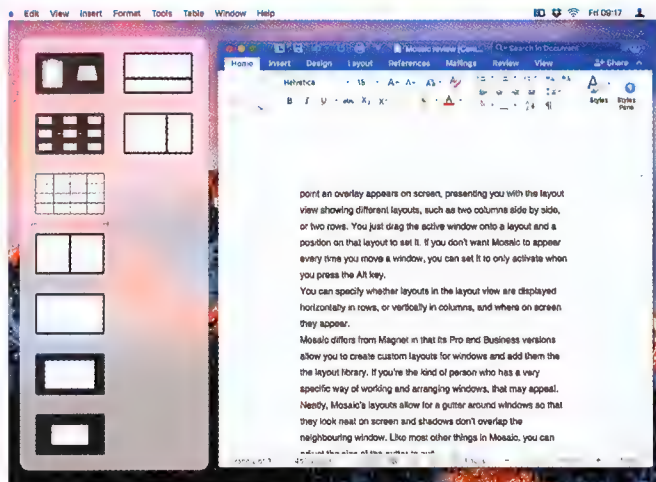
Fullscreen views and Mission Control are great for quickly swiping between apps and for focusing on a single app, but what about those occasions where you need to frequently swap between apps, either because you're working on a document that references another, or because you need access to resources stored in a different folder?

That's where Mosaic comes in. Mosaic lets you easily manage windows so that they occupy a set area on your screen, allowing you to view two or more simultaneously at the tap of a keyboard shortcut, or a quick drag and drop.

Mosaic sits in the background until you drag a window, at which point an overlay appears, presenting you with a view showing different layouts – such as two windows side by side or a grid. Just drag the active window onto a position on that overlay to set it. If you don't want Mosaic to appear every time you move a window, you can set it to activate only when you press Option. You can also specify whether layouts in the overlay are displayed in rows or columns, and where on the screen the overlay appears.

Neatly, Mosaic's layouts allow for a little extra space around windows so they look attractive on your screen, and so that shadows don't overlap the neighbouring window. And as with most other things in Mosaic, you can adjust the size of the spacing to suit.

The Standard edition allows you to specify an exact window size and position on your desktop, while the Pro



(\$44) and Business (\$6 monthly subscription) versions also allow for constraints-based layouts for windows using pixel counts or percentages. If you have a very specific way of working with and arranging windows, that may appeal. Also, the Pro and Business versions both support the MacBook Pro's Touch Bar, and offer a remote control app for iOS that lets you resize the active window on your Mac by tapping a layout on your iPhone or iPad.

Some features that we would have liked to be included in the Standard version, such as keyboard shortcuts and Touch Bar support, are limited to the Pro and Business Editions. However, the higher cost of the Pro edition pays off if you want to use Mosaic on multiple Macs, as in addition to extra features it can also be used on up to five computers. **Kenny Hemphill**

Nuance PDF Converter

Converter, editor and uh... OCRer.

\$125 | TINYURL.COM/APC443-NUANCE



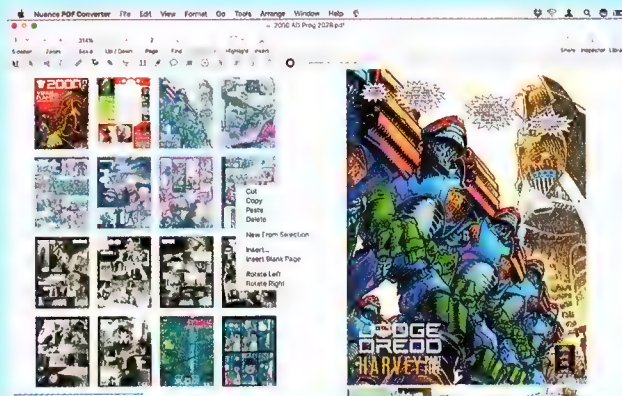
This app isn't just for converting PDFs. You can add annotations, rearrange pages, make edits and weld new PDFs to your existing ones. It also includes OCR, to add a searchable text layer to scans.

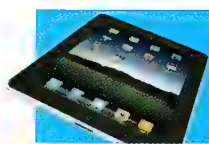
In our tests, a high-res invoice had minimal errors, but a medium-res magazine scan became a garbled mess. Edits are possible, but fiddly, often requiring you to click and update individual words within a dialog box, rather than all the text at once. Still, for simpler documents, the feature's a user-friendly boon.

Conversions also proved variable, but were dependent on document complexity and output format. After all, you wouldn't expect a magazine layout to survive unscathed into RTF. However, we were impressed to find design-oriented table-based layouts from InDesign remained largely intact when converted to Word. Conversions go through Nuance's server, which takes several minutes.

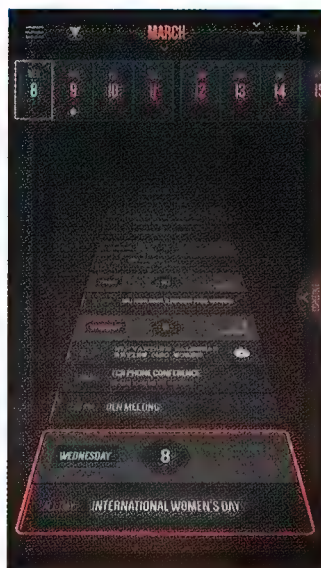
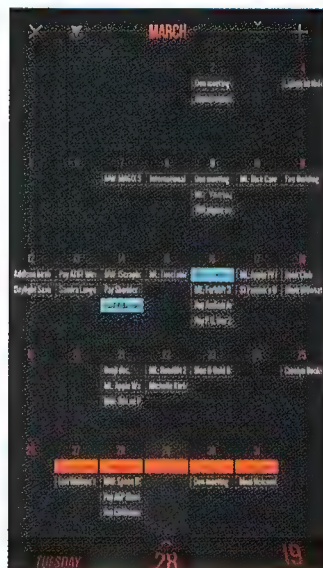
Elsewhere, the interface is usable and annotations work fine. There's even an audio option, but audio annotations don't work

in all apps (such as Preview). PDF Expert 2 is cheaper, friendlier and nicer to use, but this is a decent buy if you need conversion and OCR rather than just editing. **Craig Grannell**





App Store » iOS APPS



Vantage Calendar

Add some flair to your dates.

\$7.99 | VANTAGE-APP.COM

V Developers seem to think your calendar needs a makeover and are going out of their way to reimagine how a mobile datebook should look and function. But visual flair alone isn't enough to enhance your productivity.

Vantage Calendar is the latest iOS app to give your agenda a facelift, but unlike the competition, this one retains the features people want in this kind of app. The main view resembles a *Star Wars*-style opening title crawl, with the current day's activities at the bottom, grouped into stacks that scroll vertically into the past or future.

You can also scroll through connected iCloud, Google, Outlook or Facebook Events calendars with a horizontal swipe across the top grid followed by a tap to jump to a specific day. A tap on any event expands to full-screen, complete with all the typical details found in other apps.

Events can be assigned colours, fonts and stickers to make them stand out in the timeline, too. Such embellishments currently won't sync to other calendar apps, however.

Vantage Calendar includes weekly summary and hourly schedule views, as well as a mini-month summoned by tapping the current month's name, which displays events as coloured dots. Tap the arrow located at the bottom to expand into a slick full-month view, complete with event titles.

Curiously, the app has no landscape mode except on the iPad, where the timeline is surrounded by an excessive amount of dead space.

We liked the ability to switch an event to a to-do list item, but if you prefer a lot of alert options, you'll be disappointed here. There's also no way to search events, although this is being added. **J.R. Bookwalter**

Animatic by Inkboard

Draw your own (cat) GIFs.

FREE WITH IAP | ANIMATIC.IO



You may think creating your own hand-drawn looping gif would require a fairly complicated tutorial-heavy app. Not so. Animatic by Inkboard throws you in the deep end with no tutorial whatsoever — and, in truth, you don't really need one. By trial and error alone, within five minutes, your humble reviewer had drawn a rough stretching cat gif and shared it to the (sadly unappreciative) APC office. The process is super simple, especially since the free version of the app only gives you the basics. First things first, create a blank canvas and select which of the seven pen tools you'd like to use (varying in line angle, texture and thickness) and then hit the coloured dot on the bottom right to select your colour. Then get drawing! There's a helpful undo/redo ability and a rubber for finer altering. You can pinch to zoom in and out, and dragging the image around is achieved by using two-finger sliding (as one-finger sliding is reserved for drawing). Once you've drawn your first frame, you can start your second — and the 'ghost' image of the first frame comes with you so you have a handy guide as to where to start your second! The ghosts of the last three frames will be visible as you draw more and more frames. Once you're done, you see a preview of your creation and are given the opportunity to change the speed at which it plays and what to do with it from then. All up, we thoroughly enjoyed using this app to create a bit of silliness. While it might not serve an overly 'useful' purpose, what's the point of living without a little bit of fun, eh? **Carmel Sealey**

WakeMode

Keep your inner battery energised.

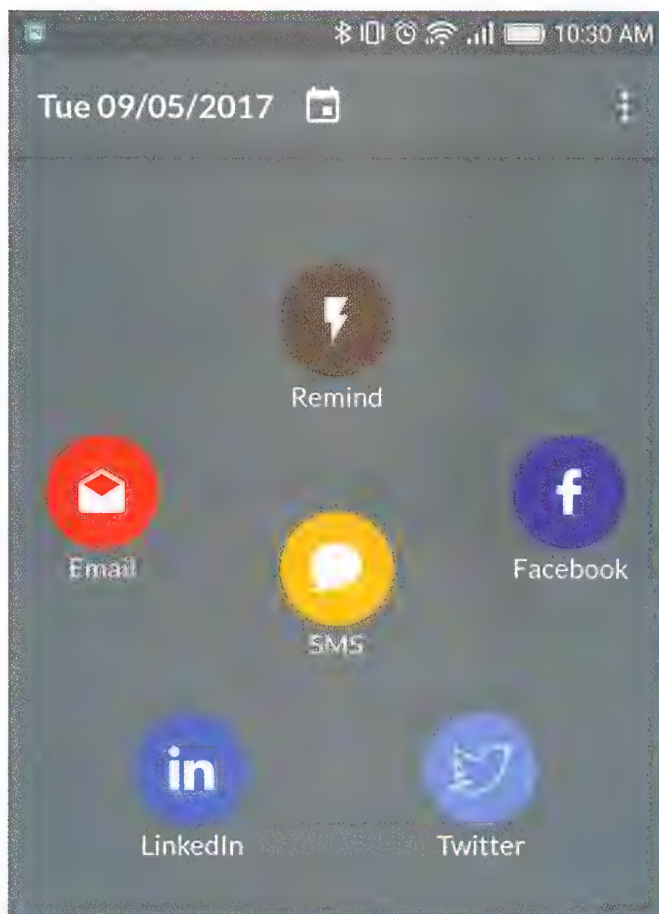
FREE | WAKEMODE.COM



This fatigue management tool tries to predict how tired you are at the end of each day by analysing your sleep data. Every night before you go to bed, you answer a few questions, then allow the app to track your sleep, either via a connected wearable or the app itself. Next morning, you are asked to respond to another set of questions and the app shows you how much energy you have in the form of a battery. Your inner battery will keep depleting as the day wears on, reminding you that you either need an energy boost or an early night. Energy boosts during the day can be in the form of a power nap or caffeine (hot beverage, soft drink or energy drink, it matters not, although go easy on those sweeties!) — pop in those details and your battery gets a little more juice. WakeMode connects with almost any Bluetooth fitness trackers and, along with machine learning to keep tabs on your habits over time, it can provide you with individualised sleep-improvement plans. If, like us, you have problems sleeping, be prepared to see some rather depleted batteries! **Sharmishta Sarkar**



Google Play » ANDROID



Do It Later

Postpone on your phone.

FREE WITH IAP | TINYURL.COM/DOITLTR



The ability to schedule your social media posts or emails is fast becoming useful beyond the realm of just publicists and preachers. There are multiple options out there for doing so, such as Buffer (buffer.com) but not many, if any, operate as simply and directly as Do It Later.

The main screen lists all your pending, finished and discarded scheduled items, neatly organised into their respective categories, and simply tapping the '+' sign allows you to create an item. You can choose email, SMS, Facebook, Twitter, LinkedIn or just a regular reminder to schedule at any time and date, repeating or one-off. There are a bunch of applicable and useful options, such as being able to resend a reminder once network availability returns, or to ask for confirmation before actually pulling the trigger.

You can optionally spend \$3.99 to remove the ad banners and get the ability to choose the date format and notification sound. Oh, and if your phone has battery-saving functionality, be sure to whitelist this app in order for it to work properly in the background. Harry Domanski

Decision Crafting

Making the emotional quantifiable

FREE | TINYURL.COM/APC443-DECISION



If, like us at APC, you can't decide between chicken salad, sushi or a cheese and onion toastie for lunch, Decision Crafting is for you. It's also for you if you're tossing up where to go on your holidays, if you should go to a party or not, or figure out which charity to honour in your will. How can one app cover both frivolous or fateful life choices? Remarkably easily, actually. You write out what your options are, then set the criteria that defines them, and give each criteria a weighting on a scale of one to ten. So you could have ease of obtaining said lunchtime option, cost, how repetitive that choice is and how tasty it'll be, with more emphasis (10 points) on taste, but less (1 point) on repetition. The app takes all these numbers, animates the result and offers an objective, purely scientific solution that can be exported to an image or CSV file. Simple to operate, sure, but you have to be careful how you phrase your categories, or you may trip over your own criteria, and the UI is a little clumsy. Nevertheless, sushi it is... and I guess I'll stick with the wife. Paul Taylor

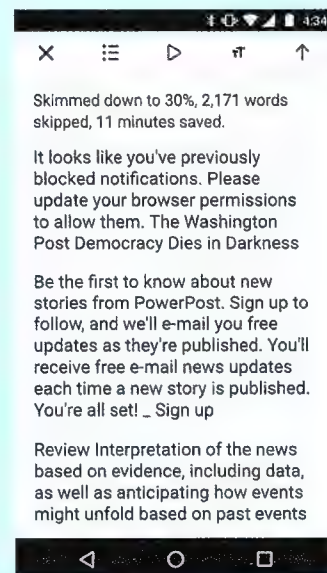
Skimcast

For those so busy they need help skimming.

FREE | WWW.SKIMCAST.COM



Nowadays, being busy is a competition. If you're seen to be not-very-busy, then you're either a failure or a bludger. You shouldn't dare do anything leisurely while people are looking, but in the event that you do get caught out say, reading the news, at least be using Skimcast. You see, Skimcast automatically cuts down internet content using some no-doubt foolproof algorithm, meaning all the less important parts of articles will be removed from your so-busy-they-could-cry eyes. For example, if I wanted to read the *New York Times'* report on Donald Trump's sacking of FBI director James Comey, it'd be possible to do it 30% quicker with Skimcast (which is exactly 1,173 words shorter). It's fine that Skimcast exists, and it seems to work OK for the most part, assuming you trust an app to decide what is and is not important. It's just weird that anyone would need to use this. Usually, an article is a certain length because it needs to be, OK? Maybe take a deep breath and do something nice for yourself for once. Shaun Prescott





Persepolis

A download manager and BitTorrent client.

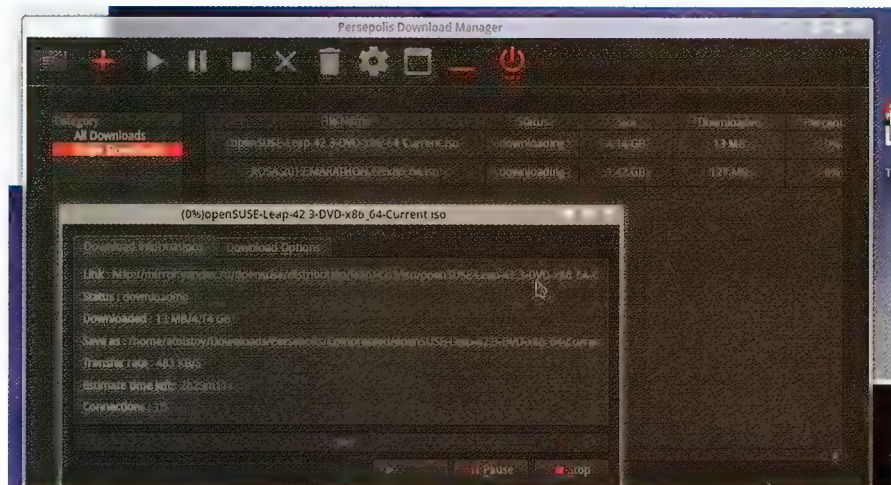
FREE | [GITHUB.COM/PERSEPOLISDM](https://github.com/persepolisdm)

Before you ask a traditional question like “Why do I need another download manager for Linux desktops in 2017?” we should mention that Persepolis is not just an addition to the litter of similar apps of this kind, but an advanced GUI for Aria2.

To make things clear, Aria2 is an alternative to Wget, which you probably know as a console command that can retrieve any file from the internet. Aria2 was created by Tatsuhiro Tsujikawa nearly a decade ago as an advanced download manager and soon gained support for many protocols, such as HTTP, HTTPS, FTP, BitTorrent and Metalink.

Among the most distinctive features of Aria2 is the ability to download several files within one command instance, and better use of available network bandwidth. It's not only a downloader, though; it's also a manager and a BitTorrent client.

Ironically, Aria2 used to have an ancient GTK1-based interface long ago,



and after it was eventually abandoned for the sake of pure command-line usage, there were no prominent graphical front-ends for Aria2.

Persepolis is here to fix it and give you a pro-looking program written with Python and Qt5. It has an appealing and neat layout, with the list of downloads at the centre of the window and quick action toolbar above.

In the simplest scenario, all you have to do is copy a link to the file you want to retrieve and press the ‘+’ button in

Persepolis. As expected, the pop-up window auto-pastes your link in the appropriate field and you only need to confirm your ambitions by pressing OK.

Persepolis reveals the inner power of Aria2 and lets you enjoy multi-segment downloading, task scheduling and torrent support right away. Its website provides instructions on installing Persepolis in Ubuntu, Fedora, Arch and openSUSE.

Alexander Tolstoy

Redshift

Should've used this sight saver.

FREE | [JONLS.DK/REDSHIFT](https://jonls.dk/redshift)

Perhaps you've read about the highlights of the new Gnome 3.24 release, which will shine in the upcoming Fedora 26 (it should be out when you read these words). We're talking here about the blue light filter, or 'night light' in terms of Gnome. The idea is to automatically adjust the colour temperature of your screen depending on the time of day. Science tells us that warmer, yellowish tones are much better for our eyes if we have to spend hours in front of computer displays in the evening or at night. However, if you run a different desktop environment, this feature is available to you via the third-party app Redshift.

Essentially, the application has two parts: the daemon that does the real job, and the GUI that lets you control Redshift settings without going to the Terminal. Automatic gamma correction doesn't depend on your display's physical interface (so an old VGA cable is no problem), but instead relies on RANDR support in your graphics driver. In other words, each and every Linux desktop system should be supported.

Redshift assumes that the neutral colour temperature is 6,500 K, while the most 'warm' night mode matches 4,000 K. The daemon calculates the value for the specific time of the day

and sets gamma with smooth, hardly noticeable transition. To guess the time of day, Redshift needs to know your location. You can manually set latitude and longitude, or rely on an automatic mechanism that uses Geoclue to determine your location based on IP.

Most Linux distros provide Redshift within standard repositories. Once you've installed it, check whether the service is running with the following:

```
# sudo systemctl status redshift.service
```

You need to replace `status` with `enable` in the command above if Redshift is not running.

Now you can start configuring the software using either Redshift GTK indicator or Redshift plasmoid, depending on your desktop.

You don't need to wait for sunset in order to see Redshift in action — the icon in the system tray lets you manually adjust the colour temperature using your mouse wheel, which gives you an immediate impression of how to use it.

Alexander Tolstoy



CREATE A FUTUREPROOF RIG!

BARGAIN PC UPGRADES

DON'T PAY TOP-DOLLAR FOR OVER-SPECCED KIT: WE DIG UP THE BEST BUDGET PARTS TO BUILD OR UPGRADE YOUR PERFECT PC FOR LESS

42

AFFORDABLE KABY LAKE MOTHERBOARDS: H270 AND B250 IN THE SPOTLIGHT

Looking for a new motherboard to accompany an Intel 7th-gen CPU? We're here to help you keep the balance and not smash the budget.

48

DDR4 FOR LESS: THE BEST LOW-COST MEMORY ON TEST

We round-up 11 sets of 8GB and 16GB DDR4 under \$200 to narrow down which offer the best performance per dollar.

54

FAST STORAGE THAT WON'T KILL YOUR WALLET: SUPER-CHEAP SSDs COMPARED

While high-end SSDs still command top-shelf prices, there's plenty of lower-priced SATA options available. We test 12.

Affordable Kaby Lake motherboards: H270 and B250 in the spotlight

Looking for a new motherboard to accompany an Intel 7th-gen CPU? Josh Collins is here to help you keep the balance and not smash the budget.

For many PC owners — even enthusiasts and pros — the increased feature set and performance found from Intel's Z-series motherboards goes well above their daily computing needs. They may have no desire for overclocking, or consider the increased memory bandwidth (and accompanying RAM frequencies) available on a Z270 to be of little benefit. Those are the two core differentiators for most users considering whether to buy a Z270 solution or opt for an option based on either H270 or B250. However, there are a few more considerations often overlooked during the purchasing process. To ensure you're well informed and ready to make the right purchase for your needs, we intend to clarify some of these considerations. Let's get stuck into it!

KNOWING YOUR H AND B FROM YOUR Z

The first item to be mindful of is the overall PCIe Gen 3.0 lanes available to the platform from the PCH. The Z270 sports a total of 24 lanes and is the maximum for the consumer platform; need more and you'll need to shift to the High-End Desktop (HEDT) platform (the X99). Next in line is the H270 chipset, featuring 20 lanes of PCIe Gen 3.0 connectivity, followed by the B250 platform with 12 lanes. These PCIe lanes are arranged into the Flex-IO to facilitate HSIO (High-Speed I/O) connectivity — that's used for graphics cards, sound cards and other add-ons through PCIe slots, and onboard devices like gigabit network interfaces and so on — as well as being shared across other platform storage resources such as M.2, U.2 and SATA, or additional USB 3.0/3.1 connectivity. All three of the core consumer chipsets, Z270, H270 and B250, feature a stock SATA 6Gbps port count of six — additional ports are served by a controller hub and consume PCIe lane allocation from the Flex-IO.

On the USB connectivity front, Z270 will feature 10 or more USB 3.0 ports, while this connectivity steps down to eight and six for H270 and B250, respectively. The total number of USB 3.0 and USB 2.0 ports are 14 for Z270 and H270 and 12 for B250. This includes both rear I/O placements and connections facilitated by internal, onboard headers — such as for front panel connectivity.

STORAGE & GAMING

Users wanting to ride the NVMe storage wave should also be aware of the maximum number of PCIe RST drives possible on each platform. From the top down, that's three, two and one for Z270, H270 and B250, respectively. On this note, the H270 platform may also reduce the lane allocation on one of the M.2 ports from PCIe x4 to x2 to reallocate the resources elsewhere. This means that, if you want to run a NVMe PCIe x4 RAID configuration, be sure to double check that the motherboard supports both ports running at x4, rather than an x4 + x2 combo.

If multi-GPU configurations are your jam, you'll need to stick to Z270 for best results. H270 and B250 don't support SLI due to the secondary PCIe graphics slot running at x4 speed and SLI requiring x8 as a minimum — however, the two lower-end chipsets can support AMD's CrossFire due to minimum x4 speed requirement.

Now we've covered the ins and outs of what each platform provides, let's dive into the actual motherboards.

MISSING IN ACTION

We extended an invitation to ASRock to submit some motherboards for this feature, but unfortunately samples were unable to be provided in time for inclusion, thus we've not been able to review any here. We hope to look at some of the vendor's B250 and H270 offerings as standalone reviews a bit further down the track.

Test configuration

Hardware

- Intel Core i7-7700K
- Crucial Ballistix Elite 2 x 4GB DDR4-3200C16 @ DDR4-2400 (C14)
- Nvidia GeForce GTX 1080 Ti Founder's Edition
- Crucial Ballistix MX300 525GB SATA SSD
- Samsung 960 EVO 1TB NVMe SSD
- Corsair AX1200i PSU
- Noctua NH-U12P heatsink

Software

- Microsoft Windows 10
- Nvidia GeForce driver 381.65 (latest at time of testing)
- PCMark 8
- HWBot X265
- Cinebench R15
- CrystalDiskMark 5
- 3DMark Fire Strike Extreme
- Far Cry Primal

Intel motherboard tech terms

- PCH** — Platform Controller Hub (i.e. Z270, H270, B250 and so on)
- Flex-IO** — Flexible Input/Output
- HSIO** — High Speed Input/Output
- GbE** — Gigabit Ethernet
- XHCI** — Extensible Host Controller Interface
- AHCI** — Advanced Host Controller Interface
- IRST** — Intel Rapid Storage Technology
- ISRT** — Intel Smart Response Technology



\$199 | WWW.ASUS.COM/AU

ASUS Strix B250F Gaming

Twins: motherboard edition.

The Strix B250F Gaming bears a striking amount of similarities with its H270 stablemate (right). On paper, the core spec is near identical. Put the motherboards side by side and you would be hard pressed to guess which is which without reading the screen-printed labelling on the PCB.

One of the main, yet subtle, differences between the B250F and H270F is the M.2 configuration. While the B250F variant sports two M.2 slots – unique for a B250-based motherboard – this isn't without constraints. The first M.2 slot is purely a SATA-based slot, meaning devices like the Intel 540S and WD Blue and Green drives from the NGFF SSD roundup in APC 441 will be right at home. However, put a PCIe device in – like the majority of NGFF devices on the market – and you will sadly be left wanting and without operational functionality. The second slot is where

you'll get the NVMe functionality and with it a full four lanes of PCIe, ensuring a device like a Samsung 960 Pro or Evo can stretch its legs. Being a B250 based motherboard, it also means a single IRST ready M.2 slot – the second one.

In lab testing, the Strix 250F Gaming performed well and ranked third overall once the data was crunched. Being one of the equal most expensive boards in the roundup, it's good to see the performance match the price tag.

Aesthetics are on point with a muted colourway punctuated by RGB illumination from the top right-hand corner of the motherboard's PCB edge.

A tidy piece of kit, but consider its twin, the H270F.

Verdict

Capable, but based on the market prices, feature sets and results, best go with the H270F instead.



\$209 | WWW.ASUS.COM/AU

ASUS Strix H270F Gaming

Outshining its stablemate... and the rest.

This one nails it. It's that simple. The H270F has hit the nail on the head, and with just a \$10 increase over the H270 competition in this roundup, the price premium is easily justified.

In the lab performance tests, the Strix H270F Gaming carved out a constant presence on the podium. For any Formula 1 fans among our readers, this was like Mercedes performance from recent championships.

However, there appeared to be one chink within the armour of this unit, that being NVMe performance when using BIOS 0607. We experienced boot issues with the platform acknowledging the SATA drives – regardless of port used – when the NVMe device was installed in port M.2_2, the very port required for full PCIe x4 bandwidth. Placing the device in M.2_1 returned SATA devices but then neutered performance due to PCIe x2 bandwidth.

Rolling back to the previous BIOS, 0308, delivered the expected functionality and performance for port M.2_2. For anyone wanting to run a PCIe x4 NVMe drive, be mindful of this, and if issues arise, roll back to BIOS 0308, then performance and functionality is as it should be. Beside this issue, BIOS 0607 was all good.

Delivering the same muted aesthetics of the rest of the Strix Intel 200-series chipset motherboards and with a dash of RGB lighting beneath the top right-hand corner of the PCB, the Strix H270F Gaming is pleasant to the eyes.

Though the priciest 'board within the roundup, if it sits within your budget, go for it and enjoy leading performance.

Verdict

A well specced, aesthetically pleasing, to the letter H270 solution. Well done, ASUS.





\$185 | WWW.GIGABYTE.COM.AU

Gigabyte Gaming B8

A potentially meme-marketed name, a missed goal.

Like hitting the uprights in a close-scoring football match, we were disappointed when our queries of the Gaming B8 product name wasn't a stroke of marketing genius for a meme-driven market. We then suggested that, if the product stands up to the APC labs rigors, we could "r8 the B8 8/8 'cause it's gr8". For those of you that groaned at that last part, perhaps it was better that Gigabyte's marketing squad didn't acknowledge that little nugget. For those that laughed — oh well, we'll smirk together.

The Gigabyte Gaming B8 features a strong core spec with general needs of gamers attended to, as well as general users. The Intel I219-V NIC driving the LAN will be welcomed by many, the ASMedia driven USB3.1 fills a spec hole for Intel B250 boards and the rest of the rear I/O is sufficient for the platform spec. Gigabyte's RGBW header implementation on its Intel

200-series mobs continues to be a plus and will likely see competitors follow suit in the next generation.

Performance-wise, the B8 had a close battle with the Strix B250F (back over the page), just missing out on taking third in the overall ranks, yet delivering gold in both the single and multi-threaded Cinebench R15 tests.

Its looks will polarise. Some will appreciate the return of the fluoro-green presence previously associated with the G1 series. However, when considering the integrated RGB implementation, the strong green colouring may be viewed by some as a strong negative — tastes and preferences will vary from user to user.

Verdict

Whether you peak or not, the Gaming B8 might still get your attention.



\$199 | WWW.GIGABYTE.COM.AU

Gigabyte H270-Gaming 3

The spec is there but performance is so-so.

Left at the back of the pack with a mediocre showing throughout the APC labs performance tests, the Gigabyte H270-Gaming 3 only reached the podium twice — each time in the Cinebench R15 CPU tests. Besides these placings, the Gigabyte H270-Gaming 3 was, for the most part, an 'also ran'.

Looking at the core spec, there isn't anything that stands out from the crowd in a unique or positive manner besides the inclusion of the RGBW header, for more detailed LED strip custom lighting, and extensive integrated RGB LED lighting. For some, the inclusion of the Killer E2500 NIC will also be a turn-off.

Peering across the dresser room to the Gaming B8 (left), the H270-Gaming 3 does sport a more involved integrated RGB lighting system, with broader light coverage thanks to the LEDs beneath the PCIe slots and LEDs wedged between the

DIMM slots. Assessing more broadly across the roundup-pack and the LED lighting featured on the H270-Gaming 3 presents the most lavish coverage, but this is a tertiary aspect of a motherboard. And for some, it could present an annoying clash with the red visual elements screen printed on the heatsinks, but if you're willing, it wouldn't be too difficult to mod these out of the equation.

The Gigabyte H270-Gaming 3 does present a good overall package, but with the ASUS Strix H270F Gaming only \$10 more and with pack-leading performance, there is little saving grace for the Gigabyte H270-Gaming 3 in this scenario.

Verdict

A fair effort, and if extensive LED lighting is your thing, this could still be on your shortlist.





\$145 | AU.MSI.COM

MSI B250M Mortar

A proper pocket rocket.

As the only micro-ATX motherboard in the roundup, the MSI B250M Mortar scored second place overall in the APC labs performance tests.

Dropping numbers on the competition, the MSI B250M Mortar commanded a confident lead in its PCMark 8 victory. Followed by strong results across all three tests within Cinebench R15 and delivering the frames with pace across 3DMark Fire Strike Extreme and Far Cry Primal.

While much of the competition is riding the RGB bandwagon, the MSI B250M Mortar is riding the older, established black-red colourway, complete with red LED lighting emanating from LEDs placed on the rear of the PCB. The rear-placed LEDs certainly create a pleasant, gentle glow, but if red isn't the colour of your aesthetic desire for your PC build, it could be an issue.

Core feature spec is on point with an Intel I219-V NIC for LAN support, M.2

PCIe x4 ready and plenty of USB 3.0 and USB 2.0 options spread across the rear I/O and internal headers.

One shortcoming is the lack of USB3.1 support, though this is largely due to insufficient PCIe lane allocation from the PCH and no hub controller implemented to facilitate USB3.1 like on some competitors. Though, with USB3.1 still yet to heavily penetrate the market, some potential buyers may see this as a non-concern.

For those looking for an element of future-proofing, this shortcoming may play a bigger role in the decision-making process prior to any purchase.

Overall, a solid little board at a strong price point.

Verdict

If the black-red colourway rocks your boat, then you're in for a blast.



\$199 | AU.MSI.COM

MSI H270 Gaming M3

One that got stuck behind the leader.

The H270 Gaming M3 had a rough stoush in this roundup.

While certainly a capable motherboard with no major gripes, it just lacks any unique attributes to stand out from the pack. Whether we're looking at performance, integrated lighting features, general aesthetics or component feature sets, the M3 is more a Jan Brady than a Marcia Brady kind of motherboard.

On paper, the dual M.2 PCIe x4 support looks attractive; however, if you're going down this route, study the resource allocation (in the manual) thoroughly to ensure your desired configuration doesn't overlap connectivity restrictions. The flexibility is certainly a positive trait but the complexity may catch out some less technically-inclined users.

Aesthetically, the H270 Gaming M3 is retro by current motherboard standards, still rocking a pure black-red colourway, which for several years was

the ubiquitous "gamer" spec. This board certainly isn't an eyesore by any means, but it does look dated alongside the competition. Interestingly, if the PCB screen printed designs were used a neutral palette and the product featured RGB LED integration, these comments of appearing dated likely wouldn't come forth — take from that what you wish.

With both the chipset and price point putting this unit up against this round-up's overall winner, it's a difficult prospect to suggest going for the MSI H270 Gaming M3 over the competing ASUS Strix H270F Gaming. Do yourself a favour and spend the extra \$10 for the superior product.

Verdict

A tight category finds an otherwise good product relegated to the minnows.



INTEL B250 & H270 MOTHERBOARDS: TEST RESULTS

	ASUS STRIX H270F GAMING	ASUS STRIX B250F GAMING	GIGABYTE GAMING B8	GIGABYTE H270- GAMING 3	MSI B250M MORTAR	MSI H270 GAMING M3
PCMARK 8 - HOME ACCELERATED (OVERALL SCORE)	5,024	4,988	5,018	4,960	5,049	5,017
HWBOT X265 BENCHMARK						
- 1080P ENCODING (AVERAGE FPS)	23.69	23.65	23.61	23.58	23.31	23.55
- 4K ENCODING (AVERAGE FPS)	4.27	4.25	4.24	4.18	4.26	4.24
CINEBENCH R15						
- OPENGL (FPS)	135.21	135.78	132.14	130.80	133.03	131.91
- CPU (MULTI-THREADED)	959	957	962	959	961	958
- CPU (SINGLE-CORE)	193	192	194	193	193	191
CRYSTALDISKMARK 5						
- SEQUENTIAL READ (Q32TI)	3,397.00	3,397.00	3,214.00	3,204.00	3,401.00	3,399.00
- SEQUENTIAL WRITE (Q32TI)	1,931.00	1,921.00	1,925.00	1,926.00	1,926.00	1,937.00
- 4K READ (Q32TI)	135.40	135.10	136.20	138.30	141.40	135.70
- 4K WRITE (Q32TI)	128.70	136.20	138.90	135.00	139.90	138.00
- SEQUENTIAL READ	2,118.00	2,116.00	1,939.00	2,140.00	2,087.00	2,347.00
- SEQUENTIAL WRITE	1,919.00	1,804.00	1,746.00	1,743.00	1,804.00	1,793.00
- 4K READ	37.47	38.31	37.79	37.77	38.20	38.31
- 4K WRITE	88.73	90.28	86.83	91.54	90.11	90.79
3DMARK (2013) - FIRE STRIKE EXTREME (FINAL SCORE)	12,331	12,306	12,281	12,294	12,274	12,325
FAR CRY PRIMAL (DX11)						
- MINIMUM FPS	46	47	47	34	47	46
- AVERAGE FPS	65	65	65	63	66	64

INTEL B250 & H270 MOTHERBOARDS: SPECIFICATIONS

	ASUS STRIX H270F GAMING	ASUS STRIX B250F GAMING	GIGABYTE GAMING B8	GIGABYTE H270- GAMING 3	MSI B250M MORTAR	MSI H270 GAMING M3
STREET PRICE	\$209	\$199	\$185	\$199	\$145	\$199
CHIPSET	H270	B250	B250	H270	B250	H270
AUDIO CODEC	REALTEK ALC S1220A ("SUPREMEFX")	REALTEK ALC S1220A ("SUPREMEFX")	REALTEK ALC 1220	REALTEK ALC 1220	REALTEK ALC 892	REALTEK ALC 1220
NIC #1	INTEL I219-V	INTEL I219-V	INTEL I219-V	KILLER E2500	INTEL I219-V	KILLER E2500
MAX RAM FREQUENCY	DDR4-2400	DDR4-2400	DDR4-2400	DDR4-2400	DDR4-2400	DDR4-2400
M.2/U.2	2 x M.2 (1 x SATA/PCIe x 2, 1 x PCIe x 4)	2 x M.2 (1 x SATA, 1 x PCIe x 4)	1 x M.2 (1 x SATA/PCIe x 2/x 4)	2 x M.2 (1 x SATA/PCIe x 2/x 4, 1 x PCIe x 2/x 4)	1 x M.2 (1 x SATA/PCIe x 2/x 4)	2 x M.2 (1 x SATA/PCIe x 2/x 4, 1 x PCIe x 2/x 4)
SATA	6 x SATA3 6GB/s	6 x SATA3 6GB/s	6 x SATA3 6GB/s	6 x SATA3 6GB/s (INC. 2 x SATA EXPRESS)	6 x SATA3 6GB/s	6 x SATA3 6GB/s
USB 3.1	x 2 (1 x TYPE-C, 1 x TYPE-A REAR I/O) VIA ASMEDIA ASM1142	x 2 (1 x TYPE-C, 1 x TYPE-A REAR I/O) VIA ASMEDIA ASM1142	x 2 (1 x TYPE-C, 1 x TYPE-A REAR I/O) VIA ASMEDIA ASM2142	x 2 (1 x TYPE-C, 1 x TYPE-A REAR I/O) VIA ASMEDIA ASM2142	NONE	x 2 (1 x TYPE-C, 1 x TYPE-A REAR I/O) VIA ASMEDIA ASM2142
USB 3.0	x 6 (2 x REAR I/O, 4 x VIA HEADER)	x 6 (2 x REAR I/O, 4 x VIA HEADER)	x 6 (4 x REAR I/O, 2 x VIA HEADER)	x 8 (4 x REAR I/O, 4 x VIA HEADER)	x 6 (3 x TYPE-A, 1 x TYPE-C REAR I/O, 2 x VIA HEADER)	x 8 (4 x REAR I/O, 4 x VIA HEADER)
USB 2.0	x 8 (4 x REAR I/O, 4 x VIA HEADER)	x 6 (4 x REAR I/O, 2 x VIA HEADER)	x 5 (1 x REAR I/O, 4 x VIA HEADER)	x 6 (2 x REAR I/O, 4 x VIA HEADER)	x 6 (2 x REAR I/O, 4 x VIA HEADER)	x 6 (2 x REAR I/O, 4 x VIA HEADER)
LIGHTING HEADERS	1 x RGB HEADERS	1 x RGB HEADERS	1 x RGBW HEADERS	1 x RGBW HEADERS	NONE	1 x RGB HEADERS
ONBOARD RGB	LIGHT BAR BACK OF PCB TOP RIGHT CORNER	LIGHT BAR BACK OF PCB TOP RIGHT CORNER	PCH HEATSINKS, AUDIO LINE, VRM, RIGHT EDGE LIGHT BAR	DIMM SLOTS, PCIE SLOTS, AUDIO LINE, VRM, RIGHT EDGE LIGHT BAR	NO RGB — RED LED FROM BOTTOM EDGE OF PCB IN EACH CORNER	NO RGB — RED LED AUDIO LINE
WARRANTY	3 YEARS	3 YEARS	3 YEARS	3 YEARS	3 YEARS	3 YEARS



X5/X7

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Calibration

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www.aorus.com

DDR4 for less

Josh Collins rounds-up 11 sets of 8GB and 16GB DDR4 under \$200 to narrow down which offer the best performance per dollar.

A quick kit of RAM can provide the subtle difference between fast and faster processing. While the industry likes to tout overall frequencies, latencies are actually just as important – you know, all those smaller numbers separated by dashes.

For this roundup, we will be operating based on a general assumed knowledge about double data rates (DDR), knowing what a DIMM is, understanding binning, have a general understanding that lower latencies are better and other associated subtleties.

Given the market dominance of Intel up until very recently, the majority of RAM kits are binned based on Intel Extreme Memory Profiles (XMP), rather than conforming to JEDEC.

JEDEC is the international memory standards organisation, which both Intel and AMD are a part of, and the standards are agreed upon by a consortium of hardware vendors.

The reliance on XMP over the past decade of Intel's market dominance has created a rocky road for AMD to travel as it reasserts itself in the enthusiast market. This scenario has been evolving since before the release of Ryzen and has seen steady and swift positive progression since the public release of Ryzen.

A massive thanks once again to local PC parts retailer Mwave (www.mwave.com.au), who helped to supply the review samples we used when testing for this feature.



\$192 | WWW.CORSAIR.COM

Frequency: DDR4-3000; Timings: 15-17-17-35; Density: 2 x 8GB

Corsair Vengeance LED (Blue) DDR4-3000 C15

Here be strong results.

This kit is strong to say the least. For a smidgen under \$200, you get a quality kit of 2 x 8GB DIMMs at a reasonably paced DDR4-3000 and with 15-17-17-35 timings. Pumping out the bandwidth to deliver increased processing across our Aorus Z270X-Gaming 7 test platform, the user experience was flawless. Booting into the BIOS, changing the system memory to read the XMP profile delivered the desired frequency, latencies and operating voltage to deliver impressive performance and with it good value.

The blue hue emanating from the light bar positioned across the top of the DIMMs delivers a pleasant but not overbearing lighting effect.

This kit is also one of the few in this roundup that we know to be using Samsung B-die ICs in a single ranked design, ensuring an optimum experience for AMD Ryzen users. This is known by the v5.30 marking on the spec stickers.

Verdict

Aesthetically pleasing and pumping the bandwidth. Beaten in performance only by the G.Skill Trident Z kit.



\$189 | WWW.CORSAIR.COM

Frequency: DDR4-2666; Timings: 16-18-18-35; Density: 2 x 8GB

Corsair Vengeance LED (White) DDR4-2666 C16

Lacking mojo.

The Corsair Vengeance LED (White) sports the same quality design and manufacturing as its blue-lit brethren but fronting with white-light LED across the top centre bar. Beside this physical trait and the spec labelling, there's nothing to separate the units by physical visual description. It's the specs that separate the stablemates. And indeed the resulting performance separates this white-light kit from the competition. Unfortunately, this separation isn't for the right reasons. Sadly, the performance delivered is representative of the rear of the pack when run through the APC labs test suite.

On the plus side, if you're game to throw your warranty aside and run out of spec (though, realistically, there's no objective way for Corsair to know whether you do this), cranking the operating voltage up from 1.20v to 1.35v will likely see the kit run higher frequency and equal or tighter latency. Or just pay the extra few dollars.

Verdict

With RAM prices so competitive, there's little wiggle room to allow for not impressing. Get the DDR4-3000 C15 kit instead.





#98 | WWW.CORSAIR.COM

Frequency: DDR4-2400; Timings: 16-16-16-39;
Density: 2 x 4GB

Corsair Vengeance LPX DDR4-2400 C16

Middle of the pack.

The cheapest kit of RAM on offer in this roundup, this 2 x 4GB kit is a mid-pack contender, striking a good balance between performance and value. Dressed in minimalist black Vengeance LPX heatsinks for a low-profile fit, this kit is sure to clear any concerns of conflict with low-hanging CPU tower coolers and attached fans. Though we tested the black kit, these modules are available in black, white, red or blue (pictured) coloured heatspreaders.

Corsair's lifetime limited warranty was once a point of difference in a competitive market; however, this level of warranty support has become the norm.

With just 1.20v required to run, this unit could be perceived as an economic way to bring down overall system power draw; however, the impact over the stock 1.35v held by numerous other kits does mean more volts are needed if exploring overclocking.



#198 | WWW.CORSAIR.COM

Frequency: DDR4-2666; Timings: 16-18-18-35;
Density: 2 x 8GB

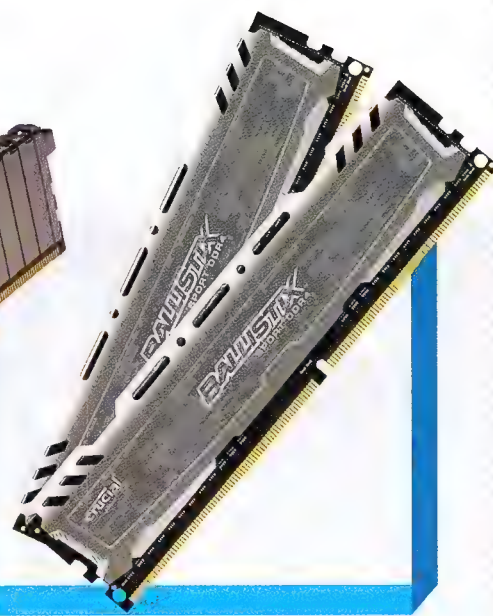
Corsair Vengeance LPX DDR4-2666 C16

Dominating the LEDs.

The 2666 C16 is almost identical in spec to its white LED cousin and, yet, our performance tests returned markedly better performance for the LPX. We re-ran the tests for the LED kit to cover for any outlying data results but observed no meaningful change.

Between the two, the LPX had almost double the bandwidth across write, read and copy, yet latency results were in line with each other. While single-threaded performance in Cinebench R15 met expectations, all multi-threaded results across Cinebench and HWBot X265 showed the LED kit fall by the wayside.

Like the 2 x 4GB kit of Vengeance LPX DDR4-2400 C16, this kit is available in black, white, red and blue heatspreaders. The sample we tested was clamoured with white armour and provided a nice contrast with the black PCB of the DIMMs. Additionally, the white clad DIMMs matched well with the Aorus Z270X-Gaming 7 used for the test bench for this roundup.



#182 | WWW.CRUCIAL.COM

Frequency: DDR4-2400; Timings: 16-16-16-39;
Density: 2 x 8GB

Crucial Ballistix Sport LT DDR4-2400 C16

No silver bullet.

Crucial is the retail arm of Micron, one of the world's largest IC manufacturers. That means Crucial is the brand found in the IT channel for branded products and Micron serves the OEM business to supply large system integrators such as Dell. Crucial's memory products have three tiers within the Ballistix range. Within this range, the Ballistix Sport variant delivers entry-level solutions, with the mid and top tiers served by the Ballistix Tactical and Ballistix Elite products respectively.

This kit represents the cheapest 16Gb (2 x 8GB) combo in the roundup. Not surprisingly, the memory bandwidth provided by DDR4-2400 frequency and C16 based timings isn't pack leading. But what it does deliver for the dollars is a fair effort. However, for a few dollars more, you could get a set of the Ripjaws V DDR4-3000 C15 (over the page) which deliver a higher grade of performance. This said, the Crucial kit does have a unique and attractive aesthetic appeal.

Verdict

While an attractive and potentially economic unit to run, it doesn't quite shine, leaving it somewhere near the middle of the pack.



Verdict

If you don't care for LED lighting, get this kit — certainly if performance is your goal.



Verdict

A nice kit of RAM, though for a few dollars extra, there is a better alternative.





\$101 | WWW.GSKILL.COM

Frequency: DDR4-2133; Timings: 15-15-15-35;
Density: 2 x 4GB

G.Skill Ripjaws 4 DDR4-2133 C15

Lacking XMP,
but without loss.

An older style of G.Skill Ripjaws, the 2133 C15 launched with the X99 platform and was the first DDR4 version of Ripjaws from G.Skill. The Ripjaws 4 present a more aggressive styling featuring increased detail elements than the V. The 4 range comes available in three assorted colours – black, red and blue – however, not all colours are available across all specifications within the range.

In terms of performance, this kit is ousted by its direct competitor the HyperX Fury DDR4-2133 C14 (opposite, far right) as a result of the different operating latencies. Running at C14, the Fury responds quicker – if only slightly – and provides 6-8% more bandwidth across the test range, and with it greater performance results.

With pricing so competitive and the HyperX Fury or Ripjaws V DDR4-2400 C15 offering better performance for similar spend, the heatspreader aesthetics here is the main drawback for consideration.



\$99 | WWW.GSKILL.COM

Frequency: DDR4-2400; Timings: 15-15-15-35;
Density: 2 x 4GB

G.Skill Ripjaws V DDR4-2400 C15

Perfect for the budget
minded builder.

If Obi-wan Kenobi was telling Stormtroopers what spec to choose for an Intel H270 or B250-based PC, he'd be saying: "This is the kit of RAM you are looking for". This delivers leading performance for the 8GB (2 x 4GB) grouping within this roundup and is perfectly complementary to an Intel H270 or B250 based PC build. Bandwidth is strong across write, read and copy, creating strong overall memory throughput, and system latency is low.

One detractor is that the kit is only available with big red heatsinks. This may go against the grain for some planning a build that doesn't centre around a red-based aesthetic, leading potential buyers to instead check out the Vengeance LPX DDR4-2400 C16 or HyperX Fury DDR4-2133 C14, which deliver performance within the same ballpark. The heatsink design is more subdued than its predecessor, but this may be a welcome element for some – aesthetics are subjective, after all.



\$189 | WWW.GSKILL.COM

Frequency: DDR4-3000; Timings: 15-16-16-35;
Density: 2 x 8GB

G.Skill Ripjaws V DDR4-3000 C15

The subtle assassin
in the roundup.

The G.Skill Ripjaws V DDR4-3000 C15 are the subtle alternative to the flashy Corsair Vengeance LED DDR4-3000 C15 kit back over the page. If you have no need for luminance within your PC, these G.Skill DIMMs will do the trick.

Clad in understated silver heatspreaders, these sticks are ready to accommodate most build aesthetics. The modules were visually right at home in our Aorus Z270X-Gaming 7 test bench.

Regarding performance, this kit is anything but subtle. It drives home the results with high bandwidth, particularly in read and copy, though we would have liked to have seen overall latency in line with the other two DDR4-3000 C15 kits – but that's being picky given the bandwidth results. The HWBot X265 results impressed after a slight stumble in Cinebench R15 multi-threaded performance in comparison with direct contemporaries.

Overall, a solid kit to consider.

Verdict

An aggressively pleasing aesthetic but better performance alternatives are available elsewhere.



Verdict

If the aesthetics are your jam, then this could be the kit of RAM you're looking for.



Verdict

Beautifully subtle in the silver heatspreader with performance to stand out.





\$203 | WWW.GSKILL.COM

Frequency: DDR4-3200; Timings: 16-18-18-38;
Density: 2 x 8GB

G.Skill Trident Z DDR4- 3200 C16

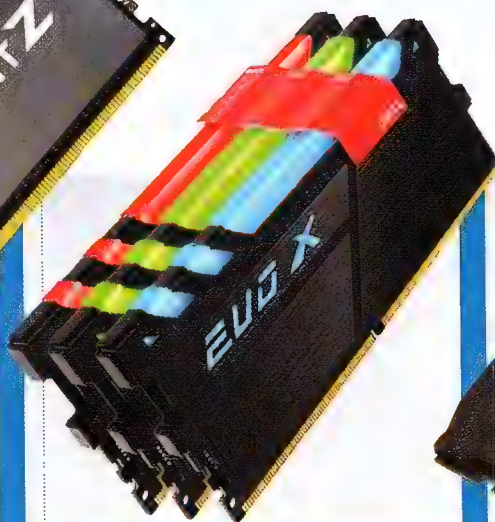
Our pick of the bunch.

Available in a range of colours, the Trident Z DDR4-3200 C16 has a beautiful complex yet elegant heatspreader design. Surveying contacts across the enthusiast sector, we failed to find a single individual that thought these DIMMs weren't attractive. Bravo to the G.Skill industrial designers.

Claiming the performance pedigree, the G.Skill Trident Z DIMMs sport the highest operational frequency among the roundup competitors, rated at DDR4-3200 and paired with comparatively tight C16-based primary timings. Delivered in a 16GB (2 x 8GB) configuration and with the aforementioned specifications, not surprisingly this kit is also the most expensive in the roundup. However, given the competitive nature of the memory market, only \$20 separates the cheapest and most expensive 16GB kits in this roundup. For a further \$20, you could spring for a kit with RGB lighting flare.

Verdict

Can these get any better? If you're into RGB lighting, they certainly can — for an extra \$20, that is.



\$185 | WWW.GEIL.COM

Frequency: DDR4-3000; Timings: 15-17-17-36;
Density: 2 x 8GB

GeIL Evo X DDR4-3000 C15

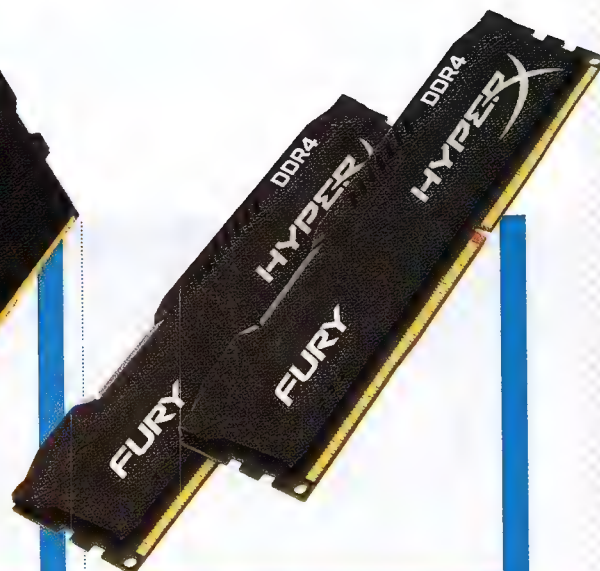
The only RGB lighting
kit in the roundup.

The GeIL Evo kit delivers capable performance thanks to its DDR4-3000 15-17-17-36 specs, yet is edged out by its DDR4-3000 contemporaries, making performance a difficulty element to justify a purchase. Turning to price point, the GeIL leans out an element of superiority, though in such a competitive market, the price differentiation holds little heat.

With performance and pricing largely a moot point, the visual game needs to be strong, then. While it may strike some as impressive from a broad look, upon closer inspection the kit lacks finesse and visual presence. The inclusion of RGB illumination is nice, especially at the price point, but it isn't the refined solution that's available from other vendors. With external power wires required to facilitate the lighting, the overall look lacks a simple approach delivered by others. Add in the always red slider that controls lighting functionality and it misses the point.

Verdict

Performance at the pointy end of the spectrum, but a clumsy lighting design.



\$105 | WWW.HYPERXGAMING.COM

Frequency: DDR4-2133; Timings: 14-14-14-35;
Density: 2 x 4GB

Kingston HyperX Fury DDR4-2133 C14

Bringing the fury?

Rounding out the 8GB (2 x 4GB) kits in this roundup, the Fury is pinched in a tight pack by its price point and performance of competitors. The kit holds down the Ripjaws 4 on most levels, yet is taken to school by the Vengeance LPX and Ripjaws V on the performance front. Especially true for the comparison with the Ripjaws V, as the kit delivers similarly subtle heatspreader design, albeit in a more attention seeking red metallic gloss.

In such a tightly fought entry-level segment, the Kingston HyperX Fury DDR4-2133 C14 is easily overlooked for cheaper and faster alternatives. There may be some saving grace in applying further voltage to explore overclocking headroom; however, that then this risks warranty, your miles may vary, and all could be said as true for competitors.

Unless the low profile black heatspreaders with silver lettering really catches your fancy, we suggest checking out the Ripjaws V.

Verdict

A nice kit of RAM, but it struggles for attention in a hard-fought category.



DDR4 SPECIFICATIONS & BENCHMARK RESULTS

VENDOR	CORSAIR	CORSAIR	CORSAIR	CORSAIR
SERIES/MODEL	VENGEANCE LED (BLUE)	VENGEANCE LED (WHITE)	VENGEANCE LPX	VENGEANCE LPX
MODEL NUMBER	CMU16GX4M2C3000C15B	CMU16GX4M2A2666C16	CMK8GX4M2A2400C16	CMK16GX4M2A2666C16W
DIMM CONFIGURATION	2x8GB	2x8GB	2x4GB	2x8GB
XMP FREQUENCY	DDR4-3,000	DDR4-2,666	DDR4-2,400	DDR4-2,666
XMP PRIMARY LATENCIES	15-17-17-35	16-18-18-35	16-16-16-39	16-18-18-35

BENCHMARK RESULTS				
AIDA64 EXTREME - MEMORY WRITE	42,160	21,390	33,552	38,344
AIDA64 EXTREME - MEMORY READ	44,458	20,027	34,839	39,648
AIDA64 EXTREME - MEMORY COPY	37,778	20,228	29,605	33,551
AIDA64 EXTREME - MEMORY LATENCY	27.3	30.4	32.2	30.1
MAXXMEM2 - MEMORY COPY (MB/S)	27,972	15,257	24,997	27,807
MAXXMEM2 - MEMORY READ (MB/S)	26,938	19,303	22,769	23,632
MAXXMEM2 - MEMORY WRITE (MB/S)	31,675	18,373	32,233	30,511
MAXXMEM2 - MEMORY SCORE (GB/S)	24.00	18.84	23.38	23.82
MAXXMEM2 - MEMORY LATENCY (NS)	9.7	9.6	9.2	9.3
CINEBENCH R15 - OPENGL (FPS)	145.82	137.71	136.12	135.56
CINEBENCH R15 - CPU (MULTI-CORE)	985	975	982	979
CINEBENCH R15 - CPU (SINGLE-CORE)	193	193	194	193
HWBOT X265 - 1080P (FPS)	24.28	23.06	23.91	24.16
HWBOT X265 - 4K (FPS)	4.38	4.18	4.32	4.36

VENDOR	CRUCIAL	G.SKILL	G.SKILL	G.SKILL
SERIES/MODEL	BALLISTIX SPORT LT	RIPJAWS 4	RIPJAWS V	RIPJAWS V
MODEL NUMBER	BLS2K8G4D240FSB	F4-2133C15D-8GRR	F4-2400C15D-8GVR	F4-3000C15D-16GVGB
DIMM CONFIGURATION	2x8GB	2x4GB	2x4GB	2x8GB
XMP FREQUENCY	DDR4-2,400	DDR4-2,133*	DDR4-2,400	DDR4-3,000
XMP PRIMARY LATENCIES	16-16-16-39	15-15-15-35*	15-15-15-35	15-16-16-35

BENCHMARK RESULTS				
AIDA64 EXTREME - MEMORY WRITE	35,296	29,784	35,367	40,878
AIDA64 EXTREME - MEMORY READ	36,173	30,634	36,383	46,347
AIDA64 EXTREME - MEMORY COPY	33,922	27,353	31,398	40,941
AIDA64 EXTREME - MEMORY LATENCY	33.2	34.0	30.1	29.6
MAXXMEM2 - MEMORY COPY (MB/S)	28,139	24,605	25,820	27,644
MAXXMEM2 - MEMORY READ (MB/S)	23,495	21,261	23,988	26,112
MAXXMEM2 - MEMORY WRITE (MB/S)	32,477	29,020	32,426	30,364
MAXXMEM2 - MEMORY SCORE (GB/S)	23.75	22.63	23.99	24.00
MAXXMEM2 - MEMORY LATENCY (NS)	9.3	9.9	9.3	9.6
CINEBENCH R15 - OPENGL (FPS)	135.17	132.61	140.70	142.99
CINEBENCH R15 - CPU (MULTI-CORE)	972	969	981	980
CINEBENCH R15 - CPU (SINGLE-CORE)	193	192	189	194
HWBOT X265 - 1080P (FPS)	24.08	23.75	23.97	24.25
HWBOT X265 - 4K (FPS)	4.36	4.29	4.35	4.38

* = JEDEC PROFILE USED DUE TO NO XMP

VENDOR	G.SKILL	GEIL	KINGSTON
SERIES/MODEL	TRIDENT Z	EVO X RGB LED	HYPERX FURY
MODEL NUMBER	F4-3200C16D-16GTZB	GEX416GB3000C15ADC	HX421C14FBK2/8
DIMM CONFIGURATION	2x8GB	2x8GB	2x4GB
XMP FREQUENCY	DDR4-3,200	DDR4-3,000	DDR4-2,133
XMP PRIMARY LATENCIES	16-18-18-38	15-17-17-35	14-14-14-35

BENCHMARK RESULTS			
AIDA64 EXTREME - MEMORY WRITE	44,155	41,853	31,727
AIDA64 EXTREME - MEMORY READ	47,927	44,358	32,509
AIDA64 EXTREME - MEMORY COPY	40,587	37,704	28,968
AIDA64 EXTREME - MEMORY LATENCY	27.7	27.7	32.3
MAXXMEM2 - MEMORY COPY (MB/S)	30,123	28,139	24,863
MAXXMEM2 - MEMORY READ (MB/S)	26,949	25,811	22,720
MAXXMEM2 - MEMORY WRITE (MB/S)	32,225	31,396	30,215
MAXXMEM2 - MEMORY SCORE (GB/S)	24.00	24.00	23.36
MAXXMEM2 - MEMORY LATENCY (NS)	9.6	9.2	9.6
CINEBENCH R15 - OPENGL (FPS)	147.23	145.69	139.07
CINEBENCH R15 - CPU (MULTI-CORE)	989	982	982
CINEBENCH R15 - CPU (SINGLE-CORE)	193	193	192
HWBOT X265 - 1080P (FPS)	24.31	24.27	23.98
HWBOT X265 - 4K (FPS)	4.37	4.37	4.32

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Super-cheap SSDs

While high-end SSDs still command top-shelf prices, there's plenty of lower-priced options. Josh Collins tests 12.

Something that the age of solid-state has made abundantly clear is that the hardware you use for storing data plays a key role in a PC's overall system performance. The storage medium can have a profound impact on system responsiveness and the user experience. Simply switching your OS drive from a comparatively slow mechanical hard disk drive (HDD) – be it 5,400rpm, 7,200rpm or even 10,000rpm – to a solid-state drive (SSD) can make a huge, positive difference to how you work or play.

The immediate positives to be taken from swapping out an HDD for a SSD include significantly improved read and write speeds, smaller and lighter drive footprints, drastically improved shock resistance and, for mobile device users, increased battery life due to reduced power consumption in both idle and active states.

When first launched a decade ago, SSDs demanded a high premium for the luxury of the above mentioned attributes. However, over the years, development in SSD technologies and the associated manufacturing techniques have helped put downward pressure on pricing. This has forced cost per gigabyte values to not just dip below the \$1/GB mark, but many drives in the entry-level market are nearing the \$0.50/GB.

This month, we've collected a range of affordable SSDs to test to help you narrow down which ones best suit your needs... and budget.



\$149 | WWW.CRUCIAL.COM

Crucial MX300 (275GB)

Unusually sized, but a great combo of value and performance.

This unit uses Micron's TLC-based 3D NAND paired with Marvell's 88SS1074 controller. The combo provides an endurance spec of 80TB written, vendor-reported performance figures of 530MB/s sequential read and 510MB/s write, and is available in a range of odd capacities. The MX300 entry-level solution has a capacity of 275GB (competitors usually feature 240–256GB) – this is due to the way Crucial allocates the available memory space using large density 3D NAND ICs and associated attributes such as garbage clean-up and cell over-run.

The 275GB drive presents impressive value with a low dollar-per-GB cost of \$0.54 that drives attention away from the likes of the Intel 540s and Samsung 850 Pro. This dominance shifts, however, when considering warranty and performance, respectively.

This drive falls behind some of the pack regarding raw performance but is still great value, especially when capacity is key.

Verdict

Solid value with lots of capacity for the money invested.



\$101 | WWW.INTEL.COM.AU

Intel SSD 540s Series (120GB)

The weak link in the Intel 540s range.

Directly comparing the Intel 540s 120GB and 240GB models, there is a sharp performance deficit for the 120GB model compared to the 240GB. Specifically, this performance deficit relates to the write speed capabilities of the 120GB drive and in benchmarks such as AS SSD that have a summarised score result that reflects a combination of read and write results, the 120GB is left lagging considerably behind the 240GB model. In real world usage, drive writes occur at a significantly lower ratio compared with drive reads and most general users won't recognise much of the performance deficit. However, for users dealing with significantly more drive writes in their workloads, the 120GB model will quickly show its slower performance.

The five-year warranty is unique; however, the cost per GB is high and there are better performing options available.

Verdict

Good drive read performance, but lacks write speed and high cost/capacity value.



Thanks again to Mwave (www.mwave.com.au) for helping provide the samples for this roundup.



\$159 | WWW.INTEL.COM.AU

Intel SSD540s Series (240GB)

Brings the expected performance, but not enough.

Featuring improved drive write performance and reduced cost per GB over its 120GB brother (left), the Intel 540s 240GB is the true competitor from Intel to attempt to do battle with the rest of the roundup, especially in the -240GB category.

Like the 120GB model, though not as extreme, the 240GB model struggles to compete on pricing. The Intel 540s 240GB SSD is the third most expensive per GB in the roundup, beaten to that unenviable crown by its 120GB stablemate and the Samsung 850 Pro – though the latter can justify it. At a solid 10c per GB more expensive, the read speeds are in line with pricing, yet write speeds are equivalent or slower than cheaper competitors, thereby making pricing a bit of a sticking point.

The saving grace for the Intel 540s 240GB in a competitive category for affordable SSDs is the five-year warranty, only matched or exceeded by the Samsung offerings.

Verdict

While the warranty may push some to buy, its price per GB really is a reason for pause.



\$79 | WWW.KINGSTON.COM

Kingston SSDNow UV400 (120GB)

The 120GB drive you want for peace of mind.

The Kingston SSDNow UV400 120GB still suffers from the lower capacity performance deficit compared with the 240GB version; however, it picks up the slack compared with the Kingston SSDNow V300 (over the page), which, like the Intel 540s 120GB, suffers from low write speeds. However, it's worth noting that, during testing, the UV400 120GB achieved 360–380MB/s write speeds across CrystalDiskMark 5 and AS SSD and an overall write score that leads the 120GB pack. The reported write speed is above the manufacturer rated 350MB/s, though the drives were all tested empty and that performance degrades as a drive is filled.

The SSDNow sits at a justifiable price point, though some may be tempted to take the SanDisk SSD Plus route. We suggest sticking with the Kingston option as we experienced a pitifully low random write IOPS in Anvil's Storage Utilities benchmark for the SanDisk SSD, albeit at a mega queue depth of 64.

Verdict

Edges out the WD Green for the 120GB category win. But the higher capacity drives are better value for money.



\$125 | WWW.KINGSTON.COM

Kingston SSDNow UV400 (240GB)

Fights a tight battle in the centre of the value pack.

The UV400 240GB is up against some stiff competition in the lower end of the -240GB segment, competing with the likes of the Intel 540s, SanDisk SSD Plus and Ultra II and the WD Green. For the most part, the SSDNow maintains a performance lead over the other contenders, with the SanDisk Ultra II 240GB alongside it in the write speeds achieved during testing.

Generally commanding a lead over the Ultra II in write results, the SSDNow drops behind on read when the queue depth is stacked. It's due to the stacked queue capability of the Ultra II that, when comparing overall summarised results in AS SSD, it leaps ahead – even compared with the likes of the Samsung 850 EVO and 850 Pro. Nonetheless, removing this outlying result from the pool, the SSDNow UV400 240GB breaks through the fog to present a valued option and even knocking on the door of the higher performance -250GB drives.

Verdict

Considering cost per GB and performance, this model is definitely worth considering.





\$80 | WWW.KINGSTON.COM

Kingston SSDNow V300 (120GB)

Read the benchmark fine print.

Let's get straight to the point here: unless you come across this unit at a discounted rate to clear stock, you should stay clear. There are simply better options available in the market for the same expenditure. Only those who don't do their research end up buying this drive at full price.

Like with other 120GB drives in this roundup, the V300 incurs a performance hit compared to the larger-capacity models from the same series. However, the vendor-stated specs are low to say the least, listing just 180MB/s read and 133MB/s write.

Our tests found the manufacturer-quoted read speed to be far off reality with the drive reaching within the 480–515MB/s range. However, the quoted write speed was much closer to reality, with the drive achieving a meagre 155–166MB/s range. At these speeds, you may as well be using a mechanical drive like a Seagate Barracuda 1TB drive and enjoy eight times the storage capacity.

Verdict

Don't pay full price for this unit. There are better options out there for the same amount.



\$148 | WWW.SAMSUNG.COM/AU

Samsung 850 EVO (250GB)

Nothing wrong with this bride's maid.

Samsung is doing amazing things in the solid-state storage space, whether it be over SATA or NVMe protocol. With the 960 series dominating the NVMe market, the 850 series has the unenviable task of backing up the 960 monsters on the SATA front.

The 850 EVO 250GB presents an entry-level capacity to the Samsung 850 Evo series of SATA SSDs. With performance SATA SSD speeds held back by the storage protocol for the most part, it's the write speeds that often set units apart. No surprise, then, that the 250GB makes it to the podium in all write tests and takes second to its Pro stablemate (right) in the overall score results for Anvil's Storage Utilities.

Backed by a five-year, 75TBW warranty and a mean time before failure of 1.5 million hours, the 250GB justifies its asking price and delivers a value-oriented option for those wanting quality but not ready to step up to the Pro.

Verdict

A very capable drive ready for those that don't require the specs of the 850 Pro.



\$189 | WWW.SAMSUNG.COM/AU

Samsung 850 Pro (256GB)

The king of the SATA SSD hill.

This is how we imagine the Samsung design meeting went down when laying out the goals for the 850 Pro. First objective is to crush the competition in performance with strong write speeds. Second is to make all other vendor warranties irrelevant. Third is to deliver the first 3D NAND consumer SSD product to market. Fourth – profit.

With a price premium that sets the unit apart from the pack (except for the Intel 540s 120GB), the 960 Pro fully justifies its premium market position. Featuring a stunning 10-year, 150TBW warranty thanks to the firm's obvious belief in the longevity of its TLC 3D NAND paired with its MEX controller, users are more likely to forget about the warranty and upgrade should it ever fail near the 10-year mark. For those needing the reassurance in the quality of their purchase, it's there in spades. If you want the best and the price doesn't concern you, buy this. If the price does worry you, get the 850 EVO (left).

Verdict

The king of this roundup (and others before it), it can seemingly do no wrong.





\$75 | WWW.SANDISK.COM.AU

SanDisk SSD Plus (120GB)

Key details missing in action.

Getting reliable, detailed specs on the SanDisk SSD Plus range is difficult to say the least. After digging around and discussing with other tech wizards, it emerged that this obscuring of facts is a purposeful ploy of SanDisk. This means the SSD Plus range could host a range of NAND and controller types, resulting in the non-static detailed specification. If the product meets the vendor-quoted read and write speeds it is given the SSD Plus moniker.

Unfortunately, this dismissive approach to core specs details makes this a product for the uninformed. It also means that there is no clarity on the subject of endurance, or for the type of flash memory technology and controller baked into the product.

The drive does deliver the approximate expected performance, but with so many uncertainties, we can't suggest this product purchase for enthusiast users — there are alternative, unobscured options available.

Verdict

Too much uncertainty for our liking. Look elsewhere.



\$125 | WWW.SANDISK.COM.AU

SanDisk SSD Plus (240GB)

Try your luck or take a known quantity — your call.

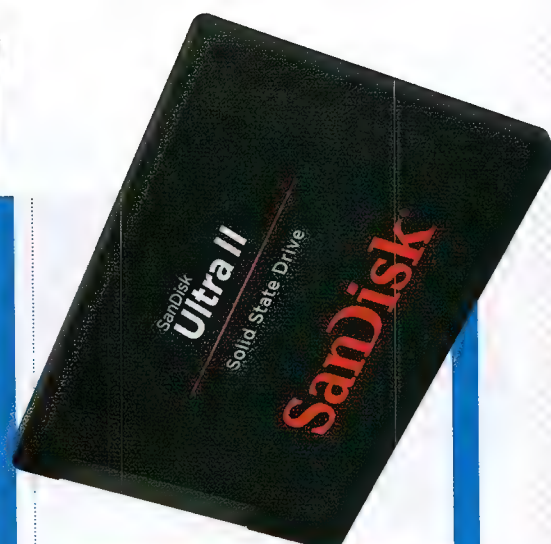
Like its 120GB counterpart (left), the 240GB pulls from a range of component vendors to create the sum of its parts. As such, there is no way for an end-user buying from a reseller to know what flash memory tech and controller pair is being used, and nor are there any available figures for endurance.

Thankfully, this 240GB unit didn't experience the same pitifully low write IOPS in Anvil's Storage Utilities benchmark that the 120GB unit did. While we concede that the queue depth of 64 is a harsh test and hammers the drive with a workload that would rarely be experienced in most general end-user usage environments, it's still a telling concern of not knowing what components are inside the unit.

While the SSD Plus 240GB delivered acceptable, albeit lower order, performance across the APC Labs tests, for the same price, you could do yourself a favour and buy the Ultra II 240GB (right) or Kingston SSDNow UV400 240GB (back over the page).

Verdict

Too many unknowns for a product in a competitive market. There are better and safer options to consider.



\$125 | WWW.SANDISK.COM.AU

SanDisk Ultra II (240GB)

Stuck in a tight battle with competitors.

If you're in the market for an affordable -240GB SSD, you could do worse than this (cough, look left). The Ultra II 240GB specs provide the details you need and want. Well, almost — the terabytes written (TBW) spec isn't available, but the scenario beats the SSD Plus range.

With our tests, the SanDisk Ultra II trades blows with the Kingston SSDNow UV400 240GB throughout the benchmarks suite, but it's the AS SSD results that are most eye catching. The Ultra II delivers impressive sustained 4K read results through a chunky queue depth of 64. Due to this result, the summarised read score is significantly boosted, which heightens the overall score. The end result is an outlier, reaching a massive 170 points ahead of the Samsung 960 Pro 256GB. While the result is impressive, it's a rare performance scenario that isn't indicative of the overall performance and is worth being aware of when reviewing the test results.

Verdict

An appropriate offering from SanDisk for PC enthusiasts.





\$139 | WWW.WDC.COM

Western Digital WD Blue PC SSD (250GB)

Positive progress for
an old platform.

For almost a decade, we've been asking, "When will Western Digital get into the SSD market?" and this question was answered in May, 2016, when WD completed its acquisition of SanDisk. This action not only strengthened WD as a storage heavyweight within the market but accelerated the company's push into the memory storage sector by giving it direct access to all that SanDisk has to offer – knowledge, manufacturing capability, the lot.

The first WD SSDs are effectively rebadged updates of current SanDisk technologies with WD branding applied. The SanDisk Ultra II (back over the page) and WD Blue drives look identical, bar the stickers. However, there is a key difference – the updated memory, controller and firmware integrated into the WD products.

In our tests, this resulted in the WD Blue returning higher write results; however, interestingly, it didn't feature the same read spike in the 4K Q64 AS SSD read test.

Verdict

This piece of updated tech delivers a nice level of progression.



\$77 | WWW.WDC.COM

Western Digital WD Green PC SSD (120GB)

A welcomed update for
a new old player.

With WD's first line of SSDs building on the foundations set by SanDisk, much of the uncertainty that shrouded the SanDisk SSD Plus range was removed and replaced with WD's clear and concise technical messaging.

Using the updated SanDisk 15nm TLC NAND flash memory paired with a Silicon Motion SM2256S, the WD Green 120GB delivers a 40TBW quota paired with 1.75 million hours MTBF for a known quantity in terms of endurance capability. The newer solution also outperforms the SanDisk SSD Plus 120GB in write performance, resolving the cripplingly slow high queue depth 4K Q64 write speeds and IOPS witnessed across AS SSD and Anvil's Storage Utilities.

Though the SanDisk SSD Plus looks similar to the WD Green, they're worlds apart in terms of implementation and spec transparency. This is a welcome move from WD. We look forward to future iterations.

Verdict

Building on the shoulders of SanDisk, WD has made a welcome update here and a positive first step.



\$119 | WWW.WDC.COM

Western Digital WD Green PC SSD (240GB)

For the value-
orientated buyer.

The WD Green 240GB achieves the lowest cost per GB, coming in at just \$0.50 and doing so with performance that doesn't make you dismiss the drive as a low-cost, low-quality unit. While it nailed the low-cost elements, the quality appears to be present.

The Green's performance isn't going to pinch the lead from Samsung, but for the cost, this model hasn't delivered a completely undesirable option from a performance standpoint. The unit does enough to get a nod and doesn't sweat it over much more than that. As long as you buy knowingly, understanding the entry level positioning of the unit, buyer's remorse shouldn't be an issue.

The WD Green 240GB has improved upon the position of its predecessor, the SanDisk SSD Plus 240GB (back over the page), though still can't take the battle to other drives in the 240GB category. For \$10–\$20 more, a better solution is available, but if every dollar counts, then the WD Green gets the job done.

Verdict

At \$0.50 per GB, the WD Green 240GB offers great value with respectable performance traits.



BUDGET SSDs: SPECIFICATIONS

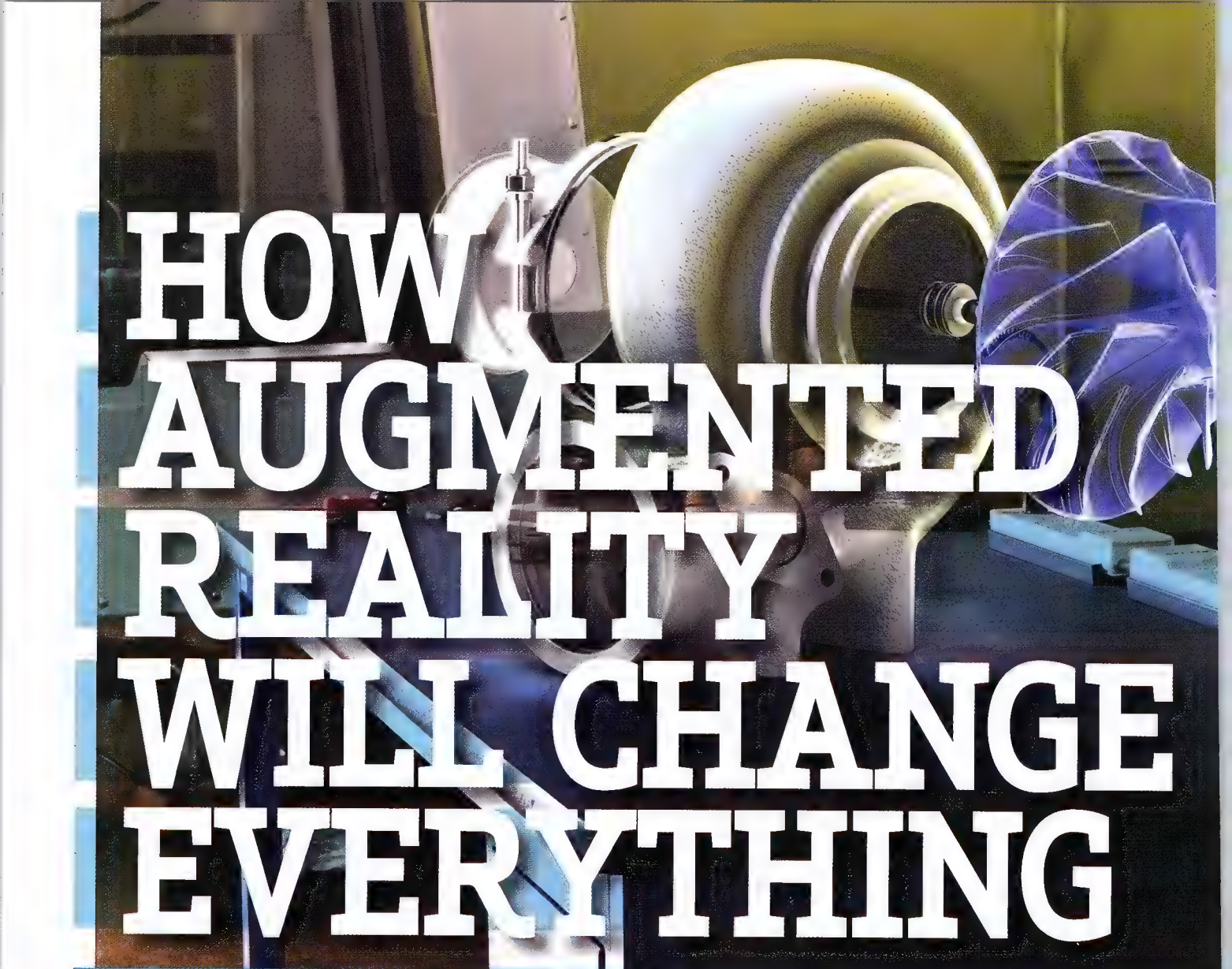
MODEL	CRUCIAL MX300	INTEL 540S	INTEL 540S	KINGSTON UV400	KINGSTON UV400	KINGSTON V300	SAMSUNG EVO 850
MODEL NUMBER	CT275MX300SSD1	SSDSC2KW120H6	SSDSC2KW240H6	SUV400S37/120G	SUV400S37/240G	SV300S37A/120G	MZ-75E250
PRICE	\$149	\$101	\$159	\$79	\$125	\$80	\$148
CAPACITY	275GB	120GB	240GB	120GB	240GB	120GB	250GB
DOLLAR PER GIGABYTE	\$0.54	\$0.84	\$0.66	\$0.66	\$0.52	\$0.67	\$0.59
ENDURANCE - TOTAL BYTES WRITTEN (TBW)	80TB	N/A	N/A	50TB	100TB	64TB	75TB
FLASH MEMORY TECHNOLOGY	MICRON TLC 3D NAND	SK HYNIX 16NM TLC NAND	SK HYNIX 16NM TLC NAND	TLC NAND	TLC NAND	MLC NAND	SAMSUNG TLC 3D V-NAND
CONTROLLER	MARVELL 88SS1074	SILICON MOTION SM2258	SILICON MOTION SM2258	MARVELL 88SS1074	MARVELL 88SS1074	SANDFORCE SF-2281	SAMSUNG MGX
WARRANTY (LIMITED)	3 YEARS	5 YEARS	5 YEARS	3 YEARS	3 YEARS	3 YEARS	5 YEARS OR 75TBW
MODEL	SAMSUNG 850 PRO	SANDISK SSD PLUS	SANDISK SSD PLUS	SANDISK ULTRA II	WD BLUE	WD GREEN	WD GREEN
MODEL NUMBER	MZ-7KE256	SDSSDA-120G	SDSSDA-240G	SDSDHII-240G	WDS250G1B0A	WDS120G1G0A	WDS240G1G0A
PRICE	\$189	\$75	\$125	\$125	\$139	\$77	\$119
CAPACITY	256GB	120GB	240GB	240GB	250GB	120GB	240GB
DOLLAR PER GIGABYTE	\$0.74	\$0.63	\$0.52	\$0.52	\$0.56	\$0.64	\$0.50
ENDURANCE - TOTAL BYTES WRITTEN (TBW)	150TBW	N/S	N/S	N/S	100TBW	40TBW	80TBW
FLASH TECHNOLOGY	SAMSUNG TLC 3D V-NAND	NOT DISCLOSED	NOT DISCLOSED	SANDISK 19NM TLC	SANDISK 15NM TLC	SANDISK 15NM TLC	SANDISK 15NM TLC
CONTROLLER	SAMSUNG MEX	NOT DISCLOSED	NOT DISCLOSED	MARVELL 88SS59190	MARVELL 88SS1074	SILICON MOTION SM2256S	SILICON MOTION SM2256S
WARRANTY (LIMITED)	3 YEARS	5 YEARS	5 YEARS	3 YEARS	3 YEARS	3 YEARS	5 YEARS OR 75TBW

BUDGET SSDs: TEST RESULTS

VENDOR	CRUCIAL	INTEL	INTEL	KINGSTON	KINGSTON	KINGSTON	SAMSUNG
MODEL/SERIES NAME	MX300	540S	540S	SSDNOW UV400	SSDNOW UV400	SSDNOW V300	850 EVO
MODEL NUMBER	CT275MX300SSD1	SSDSC2KW120H6	SSDSC2KW240H6	SUV400S37/120G	SUV400S37/240G	SV300S37A/120G	MZ-75E250
CAPACITY	275GB	120GB	240GB	120GB	240GB	120GB	250GB
CRYSTALDISKMARK 5.2.0							
- READ - SEQ. Q32TI (MB/S)	535.2	561.6	561.9	551.7	545.5	514	552.3
- READ - 4K Q32TI (MB/S)	120.2	119.4	120.4	120.6	121.4	109.8	120.4
- WRITE - SEQ. Q32TI (MB/S)	511.5	204.1	503	379.4	500.6	166.7	524.2
- WRITE - 4K Q32TI (MB/S)	114.7	112.6	115.7	113.3	115.9	110	114.9
AS SSD BENCHMARK 1.9							
- READ - SEQUENTIAL (MB/S)	501.15	506.71	508.2	453.84	512.24	481.43	517.59
- READ - 4K (MB/S)	23.4	23.58	25.6	25.27	28.57	18.28	34.51
- READ - ACCESS TIME (MS)	0.06	0.057	0.056	0.065	0.068	0.131	0.055
- READ - SUMMARISED SCORE	183	182	217	175	186	130	199
- WRITE - SEQUENTIAL (MB/S)	485.92	204.04	419.78	362.58	481.54	157.8	501.24
- WRITE - 4K (MB/S)	61.84	54.47	58.05	54.99	57.28	58.77	63.36
- WRITE - ACCESS TIME (MS)	0.06	0.065	0.062	0.063	0.063	0.235	0.056
- WRITE - SUMMARISED SCORE	217	138	198	154	211	176	220
- OVERALL SUMMARISED SCORE	502	408	532	425	503	364	535
ANVIL'S STORAGE UTILITIES 1.1.0							
- OVERALL READ SCORE	1,401.51	1,355.3	1,374.52	1,418.87	1,507.74	1,267.49	1,596.03
- OVERALL WRITE SCORE	1,204.57	666.29	1,105.65	1,024.17	1,188.41	838.55	1,232.31
- OVERALL SCORE	2,606.08	2,021.59	2,480.17	2,443.04	2,696.15	2,106.05	2,828.33
- RANDOM READ IOPS (QUEUE DEPTH 128)	20,411.4	20,449.7	20,430.4	20,403.7	20,391.3	15,789.4	20,453.2
- RANDOM WRITE IOPS (QUEUE DEPTH 64)	19,796.9	15,212	20,095.1	19,778.5	19,130.5	19,677.8	19,214.1

BUDGET SSDs: TEST RESULTS (CONT.)

VENDOR	SAMSUNG	SANDISK	SANDISK	SANDISK	WD	WD	WD
MODEL/SERIES NAME	850 PRO	SSD PLUS	SSD PLUS	ULTRA II	BLUE	GREEN	GREEN
MODEL NUMBER	MZ-7KE256	SDSSDA-120G-G26	SDSSDA-240G-G26	SDSDHII-240G-Q25	WDS250G1B0A	WDS120G1G0A	WDS240G1G0A
CAPACITY	256GB	120GB	240GB	240GB	250GB	120GB	240GB
CRYSTALDISKMARK 5.2.0							
- READ - SEQ. Q32TI (MB/S)	552.7	551.6	547.5	560	561.3	557.4	557.7
- READ - 4K Q32TI (MB/S)	119.9	119.4	120	121.4	124.2	119.6	120.3
- WRITE - SEQ. Q32TI (MB/S)	534.5	407	451.3	505.3	537.2	408.4	470.1
- WRITE - 4K Q32TI (MB/S)	115.2	108.9	112.3	116.9	118.3	109.5	113
AS SSD BENCHMARK 1.9							
- READ - SEQUENTIAL (MB/S)	519.05	519.75	517.26	506.51	480.72	525.35	525.51
- READ - 4K (MB/S)	33.31	15.09	11.98	26.09	25.66	17.33	15.06
- READ - ACCESS TIME (MS)	0.054	0.065	0.063	0.062	0.081	0.064	0.063
- READ - SUMMARISED SCORE	220	123	173	346	226	174	218
- WRITE - SEQUENTIAL (MB/S)	501.49	386.32	429.18	473.7	494.8	386.07	444.53
- WRITE - 4K (MB/S)	63.54	52.05	52.32	52.68	43.22	53.81	54.85
- WRITE - ACCESS TIME (MS)	0.056	0.173	0.0236	0.072	0.092	0.146	0.165
- WRITE - SUMMARISED SCORE	221	92	197	207	200	141	168
- OVERALL SUMMARISED SCORE	566	278	457	736	552	404	499
ANVIL'S STORAGE UTILITIES 1.1.0							
- OVERALL READ SCORE	1,695.62	1,286.05	1,285.27	1,369.61	1,525.51	1,322.27	1,317.32
- OVERALL WRITE SCORE	1,217.18	722.01	1,099.29	1,127.91	1,142.17	949.74	1,088.91
- OVERALL SCORE	2,909.81	2,008.07	2,384.56	2,497.51	2,667.68	2,272.01	2,406.23
- RANDOM READ IOPS (QUEUE DEPTH 128)	20,392.1	20,251.4	20,392.5	20,423.3	20,427.9	20,422.2	20,414.6
- RANDOM WRITE IOPS (QUEUE DEPTH 64)	20,347.3	1,210.5	19,010.3	19,876.8	19,351.3	17,079.7	16,744.9



HOW AUGMENTED REALITY WILL CHANGE EVERYTHING

IT COULD REVOLUTIONISE EVERYTHING FROM MEDICINE TO ONLINE SHOPPING AND JUST ONE IMPLEMENTATION OF THIS TECH GENERATED OVER £3950 MILLION IN 2016. DARREN YATES EXPLAINS AUGMENTED REALITY AND WHAT IT MEANS FOR OUR FUTURE

If you were looking for a candidate for 'Mobile Game of 2016', it'd be difficult to go past *Pokémon GO*. The game itself managed to generate a staggering US\$950 million over the second half of the year and instantly popularised this seemingly new technology colloquially referred to as 'AR'. But what is 'augmented reality', how does it differ from virtual reality and, importantly, where are we likely to see it next?

WHAT IS 'AR'?

What constitutes 'virtual reality' is up for debate, and there's probably even more questions surrounding how to best define 'augmented reality'. For many of us, our first contact with what usually passes for AR was a hologram of a feisty space princess summoning an ageing warrior in *Star Wars: Episode IV – A New Hope*.

However, the tech industry wants to broaden horizons and avoid pigeon-

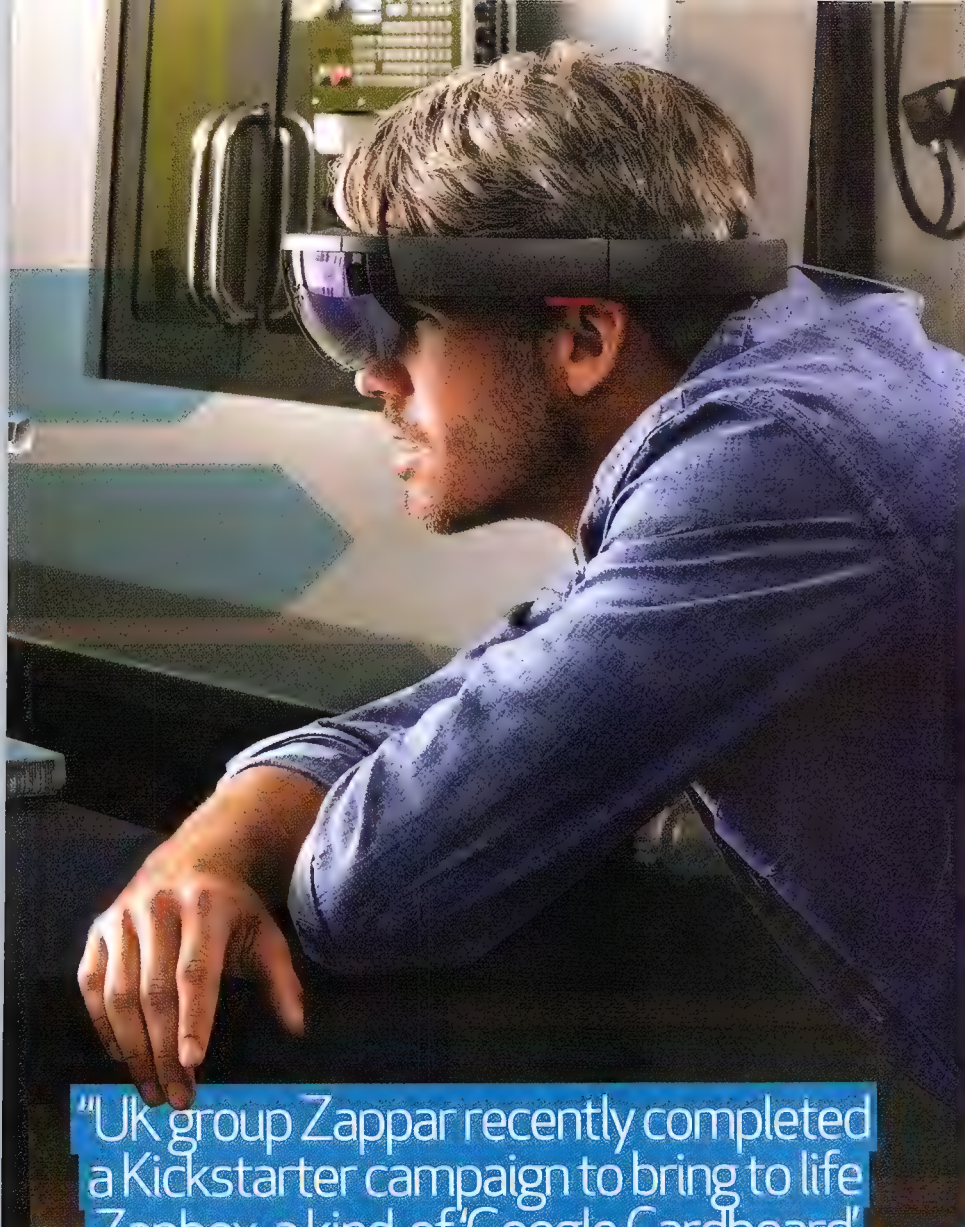
holing AR into just fancy holographic displays. A broader definition gaining traction is that AR is any real-world view overlaid with digital data, whether vision, sound or graphics. Yep, that's pretty broad, but it does ensure AR doesn't have to necessarily involve strapping on a headset. In fact, you've probably already enjoyed plenty of AR in the comfort of your own living room without realising it – the 'Hawk-Eye' ball-tracking overlays used by the Nine TV Network during cricket coverage and the Seven Network during the Australian Open tennis are perfect examples of the growing use of AR in television (tinyurl.com/zbc7t64).

When it comes to deciphering the difference between augmented and virtual reality, it's much easier – augmented reality still deals in the real world as its base, whereas even reality itself is digitally loaded in VR. Despite plenty of recent VR examples, *Pokémon GO* clearly holds reign as

the pop-culture icon for AR over the last 12 months.

STRATOSPHERIC BEGINNINGS

But while *Pokémon GO* may have introduced the mainstream to AR, in reality, AR is hardly new – in fact, you could argue its origins date back to World War II. The scourge of night bombing over London during the early period of the war drove the Royal Air Force (RAF) to develop technology to deal with the menace. The engineers and scientists at the Telecommunications Research Establishment (TRE) invented Air Intercept (AI) radar to help fighter pilots locate enemy aircraft at night. According to the book *British Aircraft Armament Vol. 2: RAF Guns and Gunsights from 1914 to the Present Day* by R. Wallace Clarke, one of the later modifications developed during 1942 involved using a cathode-ray tube (CRT) to project an image of the radar display,



"Uk group Zappar recently completed a Kickstarter campaign to bring to life Zapbox, a kind-of 'Google Cardboard' alternative to HoloLens, but with greater control and camera functionality."



Lenovo's new Phab 2 Pro features Google's Tango AR technology.

a gunsight ring and an artificial 'horizon' onto the aircraft windscreen – the world's first head-up display (HUD). However, despite some success during trials, test pilots reportedly offered plenty of suggested improvements and with development efforts more focussed on radar itself, the 'Pilot's Indicator Display' (PID) never made it into active service during the war. A practical system for aircraft detection using radio waves had only been proven to work in 1935, so for scientists and engineers to have a working predecessor of today's HUD by 1942 using technology many would now consider 'prehistoric' was seriously impressive.

Since those early days, the computing horsepower required to power most AR applications has kept the concept out of the lounge room. However, thanks to the rapid performance growth in mobile processors and the overall feature capability of smartphones, AR is now breaking into the mainstream – and not just with *Pokémon GO*.

MIXED REALITY

But just to confuse things a little more, there is a third reality form that has the potential to exceed both AR and VR and it's called 'mixed reality' (MR) – this is where real and virtual realities not only collide, but interact with each other, the virtual world affecting the real world. In practice, the terms 'AR' and 'MR' are being used interchangeably and while there's still debate over the benefit of having the two terms, the interaction between the real and virtual worlds makes MR the most complex reality form to produce. That said, we're already seeing some impressive examples reaching fruition.

HARRY POTTER AND THE AUGMENTERS

If you're not a *Harry Potter* fan, skip this next bit, but if you've ever dreamt of incanting 'Wingardium leviosa!' and watching an object levitate at the end of your wand, the opportunity might be closer than a year at Hogwarts. Digital artist Asad Malik (also going by the



HoloLens is powered by a 1GHz 32-bit Intel processor.

handle '1RIC') saw *Pokémon GO* as inspiration to try a little magic of his own and developed an MR world where spoken spells can be cast at the point of a wand (tinyurl.com/hvp9cyo). His method is built around Microsoft's HoloLens AR holographic computer to interpret hand gestures and wand movements as triggers for voice-controlled commands. At time of writing, his system had three working spells, including 'Expecto patronum!' for warding off Dementors and 'Incendio!' for setting fire to objects.

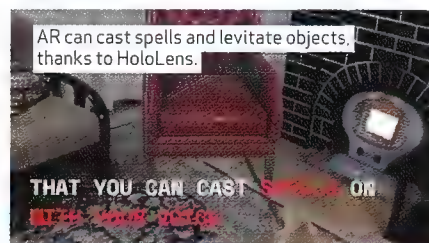
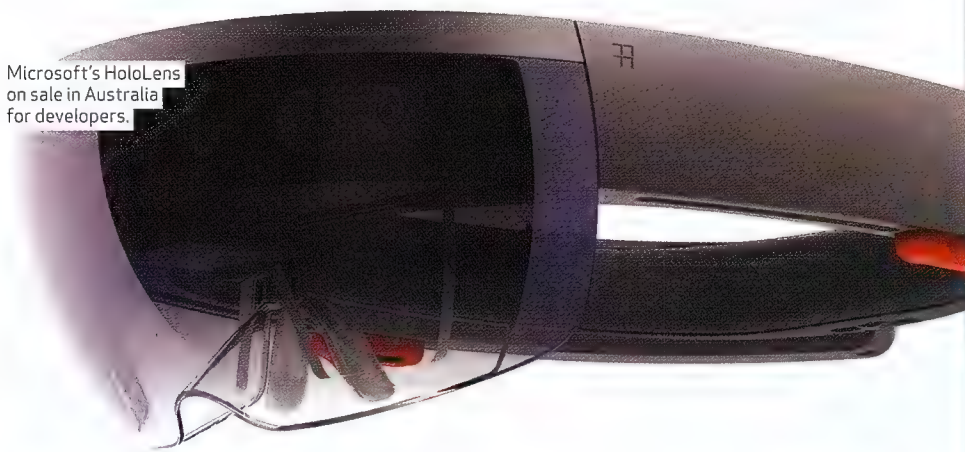
We're not sure how this sits in terms of copyright, but we'd be surprised if Harry's corporate minders weren't ka-chinging their cash registers at the thought of future merchandising possibilities. If nothing else, it's a clever pop-culture example of MR.

HOLOGRAPHIC COMPUTERS ARRIVE

HoloLens has been available in the US for most of the last year, but only began shipping in Australia last November. At the moment, it's only really designed for software developers (hence the 'Development Edition' tag) – and those with deep pockets. With a price tag starting at \$4,369, it might still be a while yet before the rest of us get our hands on one (tinyurl.com/zaye4sc).

But if that sounds a bit too rich for your back pocket, how does US\$30 grab you? UK group Zappar completed a Kickstarter campaign back in December to bring to life Zapbox, a kind-of 'Google Cardboard' alternative to HoloLens, but with greater control and camera functionality (tinyurl.com/jclwksj). Instead of a built-in computer, Zapbox relies on your smartphone to do the heavy-lifting of mixing realities, making it a kind-of AR version of Google Cardboard and its upmarket cousin Daydream View. However, while the Daydream only works with a small set of Android phones (including Google's own Pixel and Pixel XL) and is a VR-only headset platform, Zapbox offers a full AR experience and is said to work with any Android device with a

Microsoft's HoloLens on sale in Australia for developers.



"The success of *Pokémon GO* will no doubt spawn an increased uptake of AR in the classroom, although that uptake will likely be dependent on costs."

4.5-inch or larger display panel and at least Android 4.1 operating system. Basically, if you can run the Google Cardboard demos adequately, you should be Zapbox-ready.

Meanwhile, Google has reportedly been working to get more Android phone-manufacturers to make their handsets Daydream-ready, including Samsung, LG, Alcatel, Huawei, Xiaomi and ZTE (tinyurl.com/hp234co).

DANCING THE TANGO

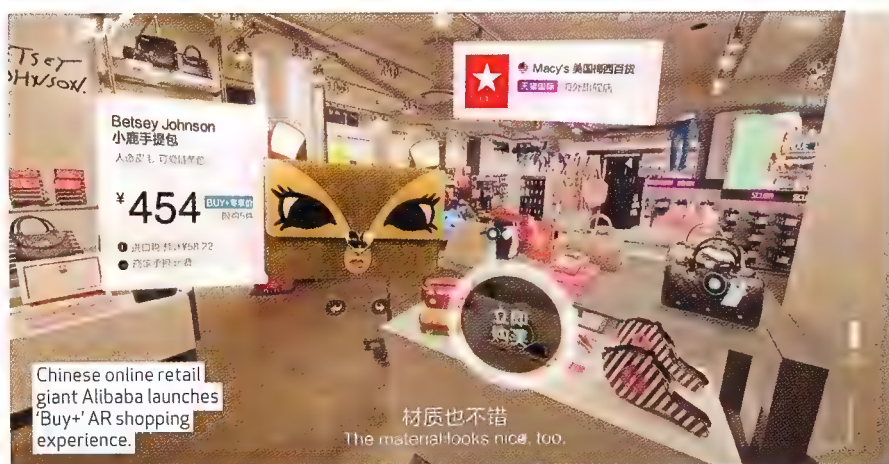
GPS (global position system) is the common method for determining a smartphone's current global location

and it's the method *Pokémon GO* uses to place the user in close proximity with a 'pocket monster' to collect. But it's also not particularly efficient – the rate of data transmission, for example, is as low as 50 bits per second (50bps). Compare that with even old dial-up modems that downloaded data a thousand times faster and it takes a lot more time to get the information you need. Throw in the fact that your phone has to communicate with satellites in space to get that data and it shouldn't surprise that GPS is pretty thirsty when it comes to draining your device's battery life.



ASUS's upcoming ZenFone AR combines Google Daydream and Tango tech.





A couple of years ago, search giant Google set up Project Tango (tinyurl.com/jk3hgss), an AR/MR platform that, among other things, doesn't need GPS to precisely identify location. By the end of 2016, Lenovo had produced the first Tango-ready device, the Phab 2 Pro. Meanwhile, Taiwanese maker ASUS is about to go a step further, combining Tango with Daydream in the up-coming ZenFone AR (tinyurl.com/jabhb4), a 5.7-inch smartphone first shown at the 2017 Consumer Electronics Show (CES) in Las Vegas and expected for release later around July.

SHOPPING WITH AR

Many of us won't dare to walk out of the house without a smartphone, even just to go to the corner shop for milk. But it's no secret that the bricks-and-mortar retail industry is facing up to the onslaught of online shopping, particularly with Amazon's imminent arrival into the Australian market. Sports giant Nike is hoping to reinvigorate the physical shopping experience the next time you walk into its Paris store. Here, shoppers are able to custom-detail their own shoe colours and styles through holographic MR tech packed into a touchscreen kiosk (tinyurl.com/hcxmipm).

However, it's not just bricks-and-mortar receiving an MR makeover. Towards the end of last year, Chinese

online retailing giant Alibaba unveiled 'Buy+', an MR/VR headset app that promises to revolutionise the online shopping experience. Rather than just a bunch of webpage lists, buyers get a 360° view and are able to walk through a virtual department store, including fashion and clothing, where they can pick up products, spin them around and get a better idea of size, colour and form (tinyurl.com/zh8ovxl). You can get a glimpse of the idea through Alibaba's YouTube video (youtu.be/HcKRBKilg).

AR IN SCHOOLS

There's a growing body of research applying AR to areas of teaching from general teaching of Year 2 students to more specific applications such as maths and geometry (tinyurl.com/zeodr9). More practically, there are dozens of AR apps designed to help teach students from their smartphone or tablet. Elements 4D (tinyurl.com/kgpmbdf) is a cool app using AR to aid in teaching the principles of chemistry and how elements combine. It uses wooden or paper blocks as targets to launch AR video.

The success of *Pokémon GO* will no doubt spawn an increased uptake of AR in the classroom, although that uptake will likely be dependent on costs – one reason why the rapid fall in AR tech prices will be watched with interest in education circles.

MEDICAL AR RESEARCH

Not surprisingly, AR has some seriously useful applications within medicine. Researchers at the Massachusetts Institute of Technology (MIT) have recently developed a system that uses AR to automate digital measurement of medical instruments via smartphones without the need for plug-in or wireless devices. Any electronic medical device that plugs into something – or someone – to measure vital signs rightly requires regulatory approval, but MIT researchers found that using a simple AR marker or 'target' can provide a reference point for capturing accurate data from measurement devices at low costs using a smartphone camera. An example is a peak flow meter (that can measure lung capacity where you blow as hard and as fast as you can for a short period). These are simple devices with no real tech to speak of, but using a small AR target and an app, the phone can accurately capture the peak flow reading via the phone's on-board camera. The idea is being promoted as a low-cost way of automating data collection in developing countries (tinyurl.com/zkg65rr).

Elsewhere, there is considerable interest for AR/MR in emergency response training. A recent research paper from the University of Birmingham details a low-cost concept that uses MR to aid training emergency personnel in aircraft procedures. Since emergency response aircraft are not always on hand during training, the concept brings in MR to replicate that experience (tinyurl.com/hue4y6f).

But one of the most impressive MR applications is by surgeons. Breast radiology and surgery researchers at Stanford University are developing a prototype system using HoloLens to overlay previous MRI scans onto the patient's breast, enabling surgeons to more accurately remove a cancer tumour and reduce the need for follow-up surgery. However, the system currently can only be used pre-surgery as it can't account for movement once surgery commences. To fix the issue, Stanford mechanical engineers have been brought in to model how human skin tissue moves, which will allow surgeons to use the system during surgery as well (tinyurl.com/hbgnpj8).

THE FUTURE

As mobile processor performance continues to improve, the future for AR looks exceedingly bright. According to a recent Citi Research report, the VR/AR market is forecast to top US\$692 billion by 2025 (tinyurl.com/zbveqz5). There's even talk it'll pass US\$1 trillion by 2035.

Pokémon GO brought AR to the mainstream, but if the forecasts are right, it looks like we're in for one heck of a ride to come. ■

how to

» QUICK TIPS

Experts solve your computing problems

APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

DRIVERS

MONITOR SCREEN STRETCHED

I updated to the Windows 10 Anniversary Edition and now my monitor screen is stretched. Both Device Manager and IOBit Driver Booster claim my drivers are up to date. What's happened?

Scott Spiers

First, we confirmed Scott's problem was down to an incorrect resolution setting, which he confirmed it was (the screen was 'stuck' at 1,024 x 768-pixels). We next asked for Scott's PC model, which revealed his Dell PC was powered by an AMD Radeon HD4300/4500 card. Sadly, this generation of cards isn't supported in Windows 10 – AMD seemingly drops support for older graphics cards much quicker than its rivals Nvidia and Intel. Nevertheless, Scott didn't have this problem prior to the Anniversary Update, and a quick check online revealed that other Radeon HD4000-series owners had successfully got their cards working in Windows 10 by downloading the last supported version of the driver – 13.1. Although rated for Windows 8, it should work in Windows 10 too. Get this from bit.ly/ati-legacy – download the Software Suite version, then double-click the setup file and follow the prompts to install the drivers.

Graham Barlow

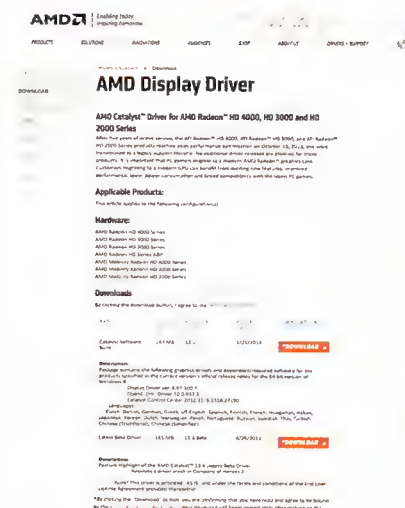
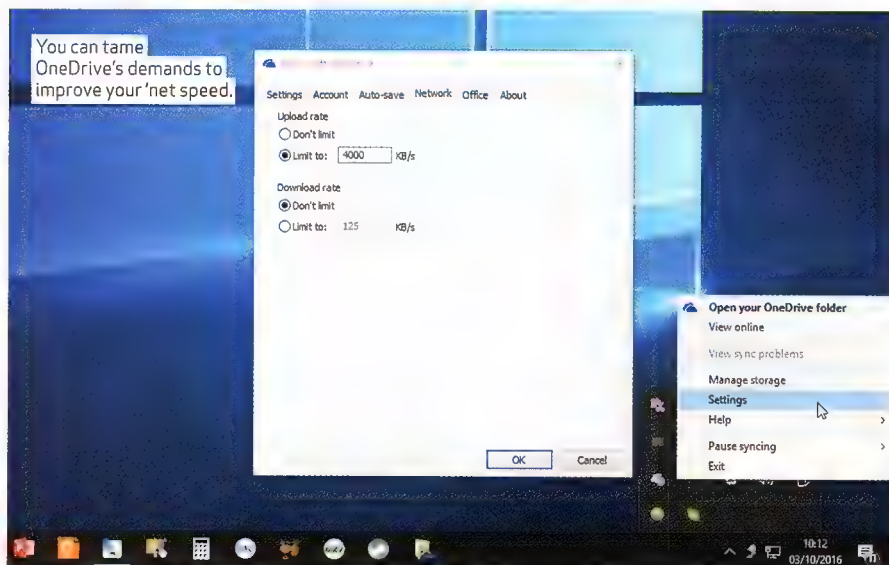
INTERNET

ONEDRIVE AFFECTING INTERNET PERFORMANCE

I have recently set up OneDrive for my own use, taking advantage of the 1TB free storage I get as an Office 365 user. I've got about 10GB to upload to the cloud, but, after setting up OneDrive, my internet connection – and powerful PC – have almost ground to a halt. What's the problem, is it fixable?

Ian McAndrew

The obvious cause of this problem was OneDrive itself – it appeared to be consuming all available internet bandwidth as well as overwhelming the PC. Luckily, there's a way to rein in its demands – click the ^ button on the Taskbar Notification area, then right-click the OneDrive icon and choose Exit. Next, open your browser



In a pinch, it may be worth trying older Windows 8 drivers if you can't get a device working on Windows 10.

and perform a speed test at www.speedtest.net – make a note of both download and upload speeds (multiply by 1,000 to get the equivalent figure in KB/s). Now type "OneDrive" into the Search box and click the 'Desktop app' link to restart OneDrive. Next, right-click its Taskbar Notification area icon as before, but this time, choose 'Settings' > 'Network' tab. Select 'Limit to:' under

'Upload rate' and set this to half your connection's upload speed in KB/s – for example, 500KB/s for a 1MB/s connection, or 4,000KB/s for an 8MB/s connection. You can set a download limit, too, but in most cases, it's capping the upload speed that will fix the problem. Click 'OK' and you'll find your PC and internet connection recover while OneDrive continues to work in the background.

Nick Peers

WINDOWS

MOVE USER FOLDERS TO NEW PARTITION

My Windows 10 PC has a large data partition I'd like to store documents and other personal files on. How can I point Windows to this partition?

Donald Lincoln

We've put together a short step-by-step guide that reveals how to move your data and let Windows know where it's now residing. It'll also show you what to do after a reinstallation in order to regain access to those folders using your newly recreated user account.

1 Create a named folder (such as 'Donald') on your data partition, then create folders inside this for Documents, Pictures, Videos and any other system folders – including

desktop and downloads – that you want to move.

2 Open File Explorer and click 'This PC' to reveal six of your user folders (or browse to 'C:\Users\<Username>' to reveal more such as Searches or Favourites). Start by right-clicking the Documents folder and choosing 'Properties'.

3 Switch to the 'Location' tab and click the 'Move...' button. Navigate to the named folder you created in Step 1, then select the Documents folder and click 'Select Folder' followed by 'Apply' and 'Yes'. Repeat for each folder you wish to move.

4 If you later reinstall Windows using the same user account, simply repeat Steps 2 and 3 to pair the folders with Windows again; if not, you may get a prompt about access being denied – if so, click 'Continue' to regain access.

Cat Ellis

SECURITY

SECURE DIGITAL DOCUMENT STORAGE

I'm sure this will resonate with other readers who are trying to switch from paper to digital – what's the best way to back up this data and keep it secure?

Colin Sexton

The simplest solution is to use cloud storage such as Dropbox, Google Drive or OneDrive, but you may want to take an additional step for particularly sensitive documents – if you use VeraCrypt (veracrypt.codeplex.com), for example, create an encrypted container file inside your cloud storage to store private files inside, providing an extra layer of security.

If you own a network drive that's billed as a 'personal cloud', you could eschew all third-party services and use that instead – either with its own proprietary software (such as Western Digital's MyCloud) or using the open-source ownCloud (owncloud.org) solution instead. Again, employ it in conjunction with VeraCrypt or similar service to ensure your data is doubly encrypted.

Nick Peers

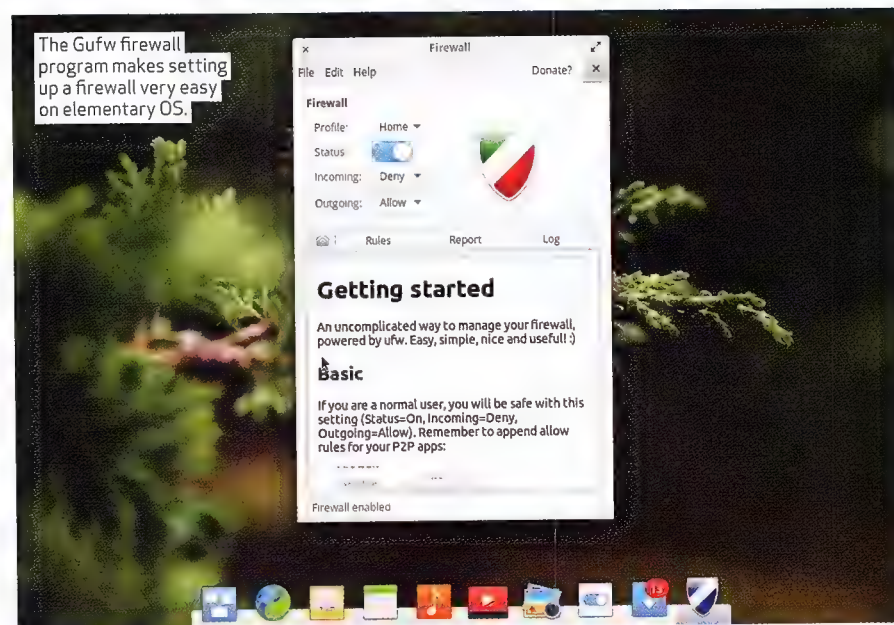
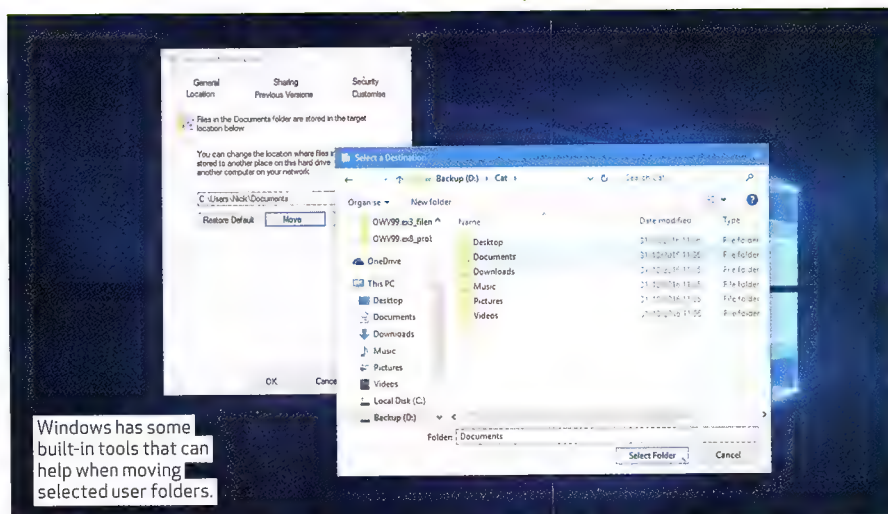
LINUX

ELEMENTARY FIREWALL

Being your average non-technical computer user who is trying his best to embrace Linux and all its wonderful choice of distros, can you explain in really easy-to-follow instructions how to set up a firewall?

I'm using elementary OS on one PC and also run Ubuntu 14 and 16 on two others. I think you have explained this a few times in your publication, but it never seems to be easy to set up and the instructions always seem to be complete gobbledygook to the average computer user!

Also, is it true that Linux distros don't need security suites or is this a complete

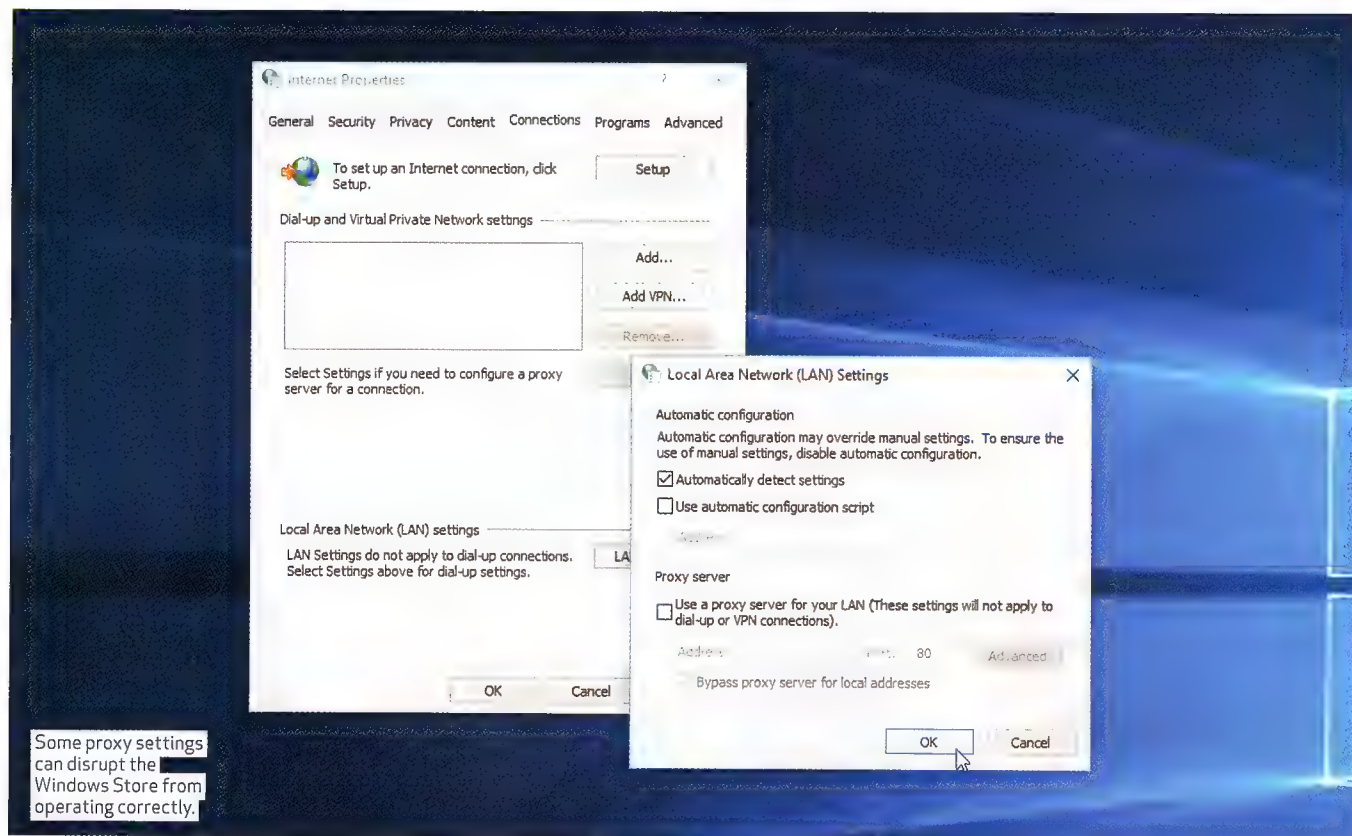


"Is it true that Linux distros don't need security suites or is this a complete myth? When you look online at Linux forums, there always seems to be conflicting advice as to whether a security suite is needed or not!"

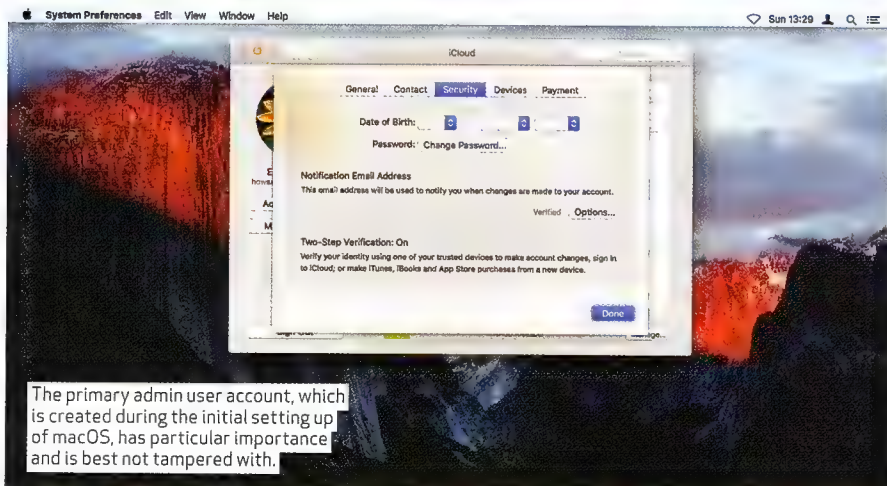
myth? When you look online at Linux forums, there always seems to be conflicting advice as to whether a security suite is needed or not! If one is needed, then can you please advise me of the best one I can use bearing in mind I am not that well clued up on computers!
Stephen Green

There are no known malicious viruses or malware out in the wild, which is why some people say you don't need security software. Linux is also fundamentally more secure than Windows, but neither

of those mean it's impervious to future attacks. My preferred line of defence against malware is Rootkit Hunter, which checks critical system files every day and warns of any changes. It also looks for suspicious network activity. It's not the most newbie-friendly of programs, but once set up, it gets on in the background and the only time you will notice it is when it emails you a warning. Once you have installed it, you need to edit, as root, /etc/defaults/rkhunter. Make sure `CRON_DAILY_RUN` and `CRON_DB_UPDATE` are set



Some proxy settings can disrupt the Windows Store from operating correctly.



The primary admin user account, which is created during the initial setting up of macOS, has particular importance and is best not tampered with.

Account for apps on your other devices to be able to launch apps and continue experiences on this device." Help!
John Wallis

This is linked to the password change affecting an app or service previously linked to that account. Ordinarily, it can be fixed by going to the Windows Store app and signing in, but John kept getting an error code – 0x8013153B – whenever he tried to open it. We pointed him to three options: type "Find and fix" into the Search bar to access the 'Find and Fix Problems Control Panel' (click 'View all'), then run 'Windows Store Apps', 'Background Intelligent Transfer Service' and 'Windows Update' in turn. All three reported problems and attempted fixes, but to no avail.

Next, we went to the Microsoft Store reset options in Tweaking.com's Windows Repair tool (www.tweaking.com), but also to no avail. But after running Windows Repair, the Store gave a different error, which John investigated. This led him to running `inetctl.cpl` from the 'Start > Run' box, then clicking 'LAN settings' under the 'Connections' tab, which revealed the proxy server box had been ticked – unticking this and clicking 'OK' twice resolved both the Store and account problems.
Nick Peers

MAC
MAC ADMIN ACCOUNT SHENANIGANS
When I bought my iMac a couple of years ago, I used Migration Assistant to set it up from my old MacBook. But that laptop used my wife's

to "yes" and set `REPORT_EMAIL` to your email address. To initialise the database, open a terminal and run:

```
# sudo rkhunter --propupd
```

This will set up the starting point as the current status of your system, so it's best run immediately after installation when you know it's clean. Now it will regularly check for suspicious activity or changes and email you if it finds anything. Firewall functions are handled by the Linux kernel, so all the firewall programs you find are interfaces to this with varying degrees of user-friendliness.

You may also find your internet router has a firewall, it's best to set this up first as it stops unwelcome traffic reaching your computer in the first place. You should also make sure that no port forwarding is enabled unless you

are running a server. That way, all incoming connection requests will be ignored. Both Ubuntu and elementary OS have firewall configuration programs in their software centres, just search for "firewall". The Ubuntu one is easier to use, but you can also find this in elementary OS under the name 'Gufw'. Once installed, they provide a point-and-click way of allowing and denying connections, both incoming and outgoing, as well as a view of recent activity.

APC Team

WINDOWS

MICROSOFT ACCOUNT PASSWORD GLITCH

I changed my Microsoft Account password and now I keep getting this Windows error message: "You need to fix your Microsoft

account as its primary user, and that was transferred across to the iMac. Each time I start up my iMac, it opens in my wife's name, and I have to log out and back in to access my account. How can I adjust the iMac so that mine is the main account, and my wife's account is removed?

Colin Heaton

The first admin user account that's created is special in macOS, so although it's possible to fudge things in the 'Users & Groups' pane and in Terminal, it's far better to make the necessary changes by setting up from a clean installation of macOS. Ensure that your iMac is fully backed up, preferably keeping an extra copy of important documents, including your keychain. Keep the backup ready with a high-speed connection to your iMac, then restart in macOS Recovery (hold 'Command-R' at startup) and use Disk Utility to erase the startup disk, then install macOS on it, making yourself the sole and admin user. During setup, use Migration Assistant to transfer just your documents and settings from the backup.

Howard Oakley

HARDWARE

FLASHING CURSOR AT BOOT TIME

My Windows 10 PC has suddenly stopped booting — after a lengthy delay at the initial boot screen, all I see is a flashing white cursor. It may be linked to a recent Windows update process. Could you shed any light for me?

Adam Collette

This usually happens when your PC's UEFI or BIOS changes your boot drive settings, which, in turn, is often symptomatic of your main boot drive no longer being detected by your PC. While it could indicate hardware failure in a worse-case scenario, it's often simply a case of powering down the computer, opening the case and checking the cables connecting your drives to the motherboard.

When you next boot up, you may need to enter your UEFI or BIOS setup utility to verify the drive is detected again, plus make it the primary boot device. This may be as simple as going to the Boot section and making it the first option under 'Boot Priorities', or you may need to first locate a section called something like 'Hard Drive BBS Properties' if you have more than one hard drive installed. Once done, save your changes and exit — you should find Windows now boots correctly.

Graham Barlow

WINDOWS

ANNIVERSARY UPDATE INSTALL ERROR

My Sony VAIO won't update to the Anniversary Update (v1607). It consistently fails, and shows the following error code:

0x800705b4. Its constant attempts to download and update are really eating into my monthly allowance. Do you have any ideas that will help with this very frustrating problem?

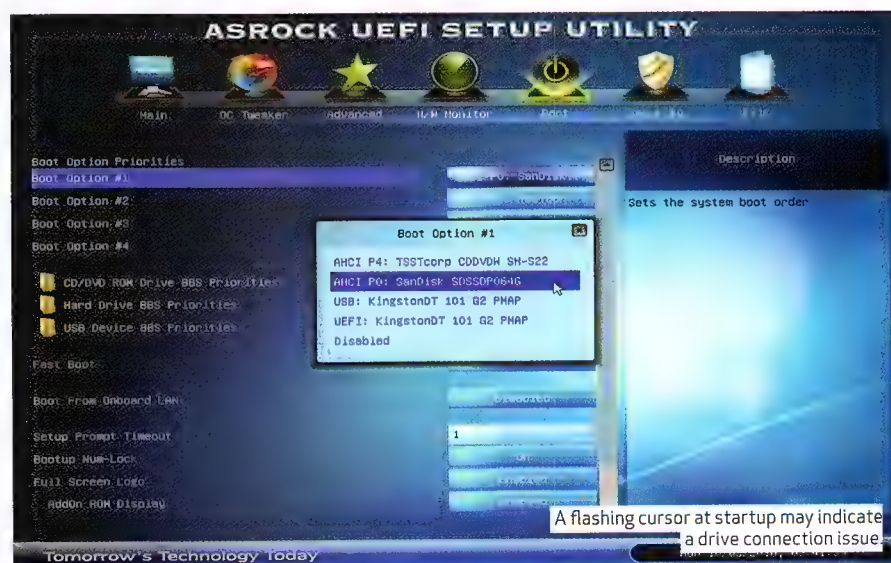
Steve Dale

There are a number of fixes you can attempt for this one. First, type "troubleshoot" into the Search box to access the 'Troubleshooting Control Panel'. Click 'Fix problems with Windows Update', then click Advanced followed by 'Run as administrator' before clicking Next.

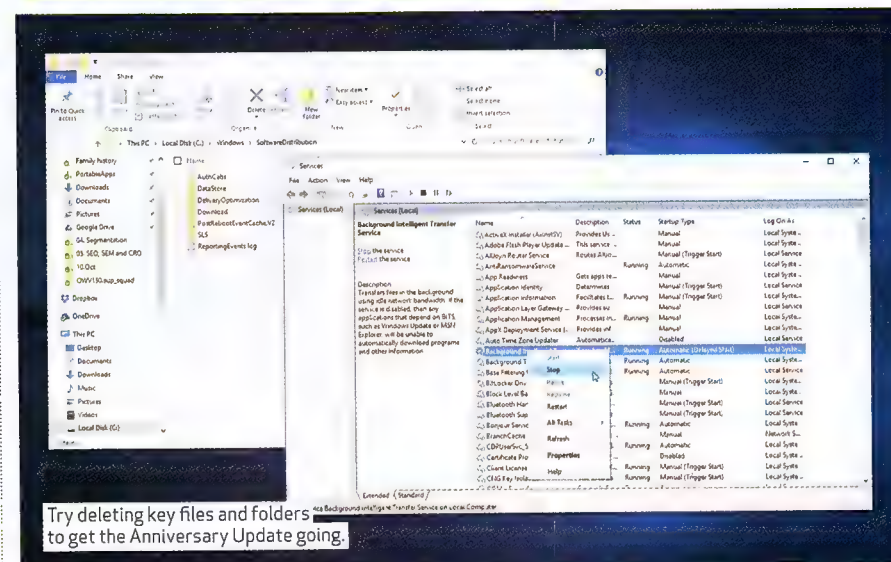
If this doesn't work, reboot, then press 'Windows-R', type "services.msc" and click OK to open the Services console. Right-click 'Background Intelligent

Transfer Service' and choose Stop. Now open File Explorer and navigate to 'C:\Windows\SoftwareDistribution'. Select everything in here — folders and files — and delete it. Not all files will delete, but it's crucial both Download and Delivery Optimization folders are removed (if they refuse to do so, reboot, stop the BITS service once more and try again). Once deleted, reboot and see if Windows Update now works correctly. If not, try downloading the standalone installer (go to 'Settings > Update & Security > Learn more', then click the 'Get the Anniversary Update' link), or download the latest version of the Media Creation Tool and 'upgrade' Windows to the latest version.

Alex Cox



"My Windows 10 PC has suddenly stopped booting — after a lengthy delay at the initial boot screen, all I see is a flashing white cursor."

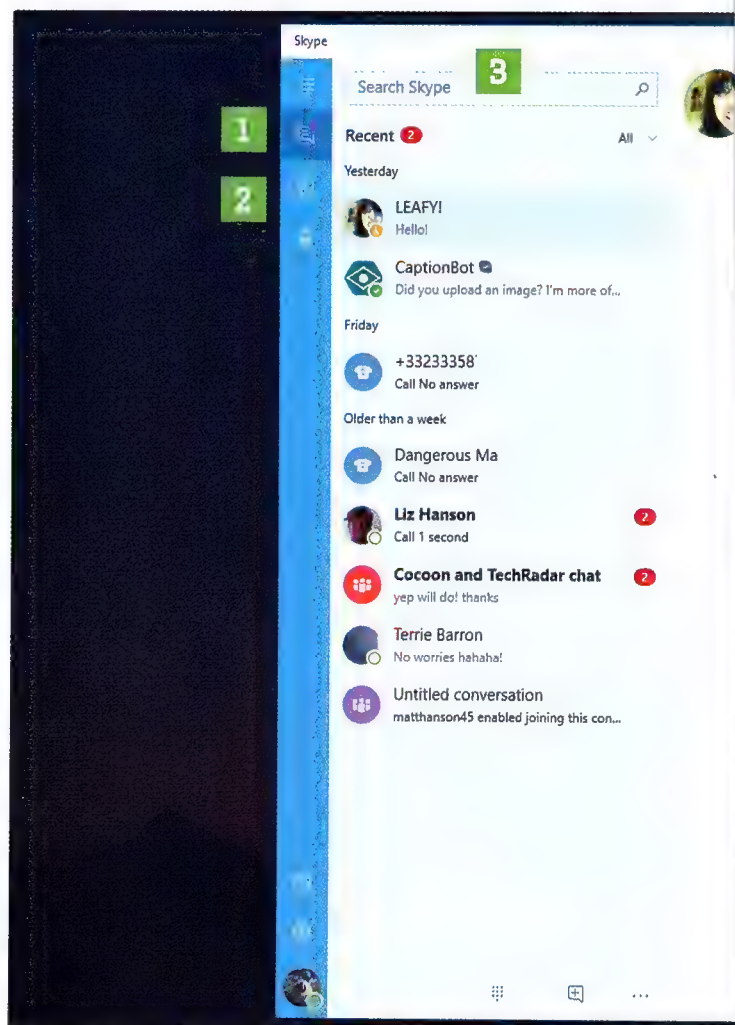


Get to grips with the new Skype

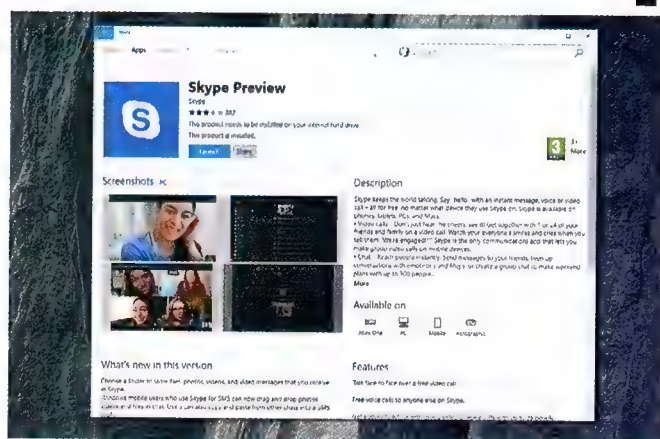
The Windows 10 Creators Update brings an overhauled Skype app. Matt Hanson shows how to use its best features.

The Windows 10 Creators Update brings a wide range of new features to Windows 10, and one of the apps that has seen the biggest change is Skype. Ever since Microsoft acquired the video calling service in 2011, it has been an integral part of Windows, seamlessly integrated into the operating system and making it incredibly easy to keep in touch with friends and family around the world via free voice and video calls. If you haven't tried Skype, then now is an excellent time to start, since it's free to download and use.

Video and voice calls to other Skype users are free – potentially saving you huge amounts of money on phone bills. You can also buy Skype credit allowing you to phone – and now text – mobile phones and landlines from the app on your Windows 10 device. Read on to find out how to get started and make use of the exciting new features...

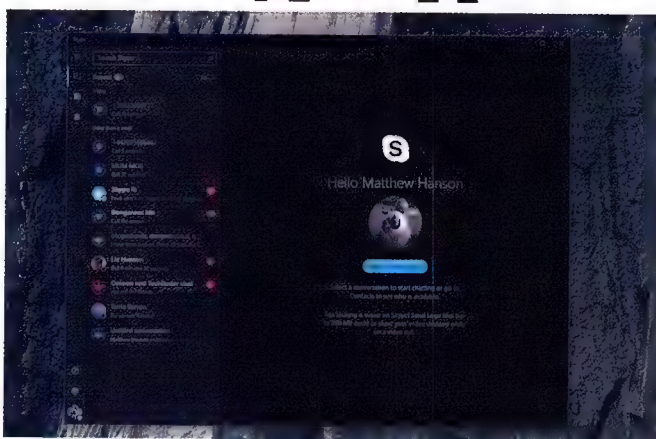


Use the new and improved Skype app



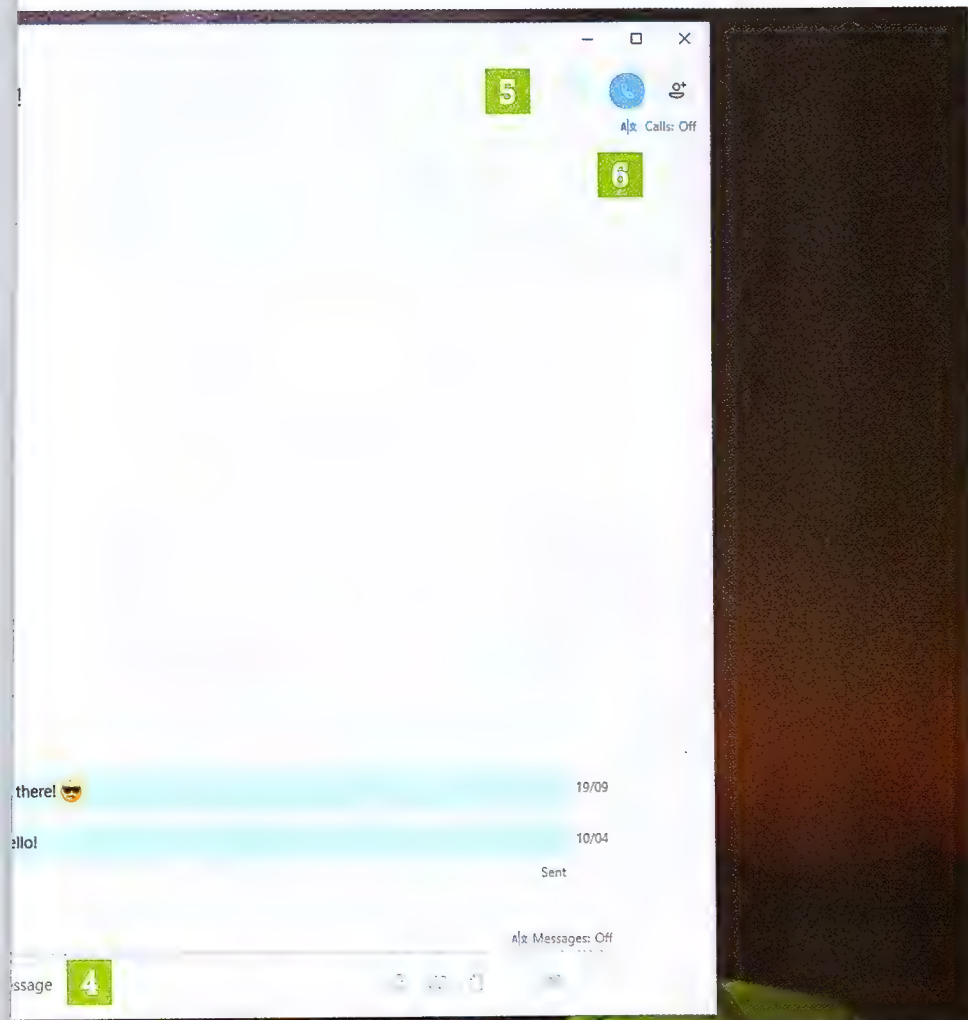
1 DOWNLOAD THE LATEST SKYPE APP

To make use of these new features (or if you've not used Skype yet), you'll need to install the latest version of its Windows 10 app. If you have the Windows 10 Creators Update, the app should be updated as well, but you can also download the new version even if you haven't updated Windows. Open the Windows Store, search for 'Skype' and select Skype or Skype Preview.



2 LAUNCH SKYPE

After making sure that the latest version of the Windows 10 Skype app has been installed, you can launch it by opening the Start menu and typing in 'Skype'. Once Skype has launched, a window will appear listing some of its new features. Don't worry about reading that too carefully, since we will explain each one here! Close the window and you'll see the main Skype interface.



1 RECENT MESSAGES

Click to view your recent messages. If you have missed any you have been sent recently, these will be highlighted here.

2 CONTACTS

Skype works closely with the People app, making it easy to find contacts you know, as well as add any new ones.

3 SEARCH

Skype now lets you search for previous messages using this search bar. You can search for people and 'bots', too.

4 CHAT BOX

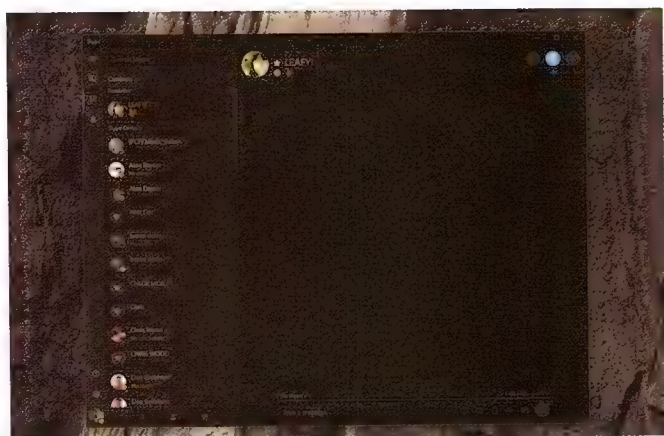
Type here to send instant messages to your Skype friends. You can also use this box to write and send SMS texts.

5 VIDEO CALL

Own a webcam? Click to start a free video call with your chosen contact. If you don't, this icon will be greyed out.

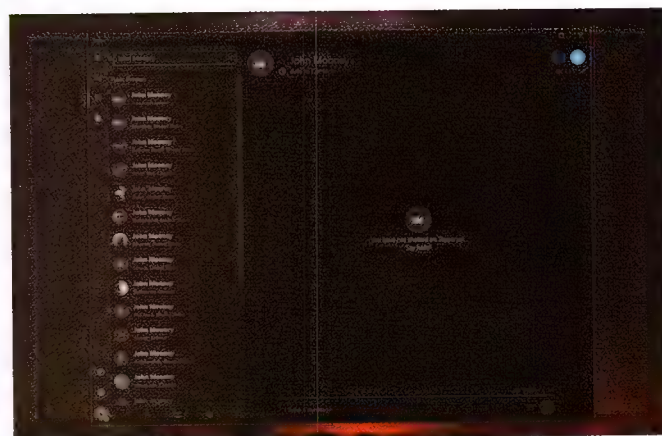
6 VOICE CALL

If your PC has a microphone, click here to start a voice call. Calls to other Skype users are completely free!



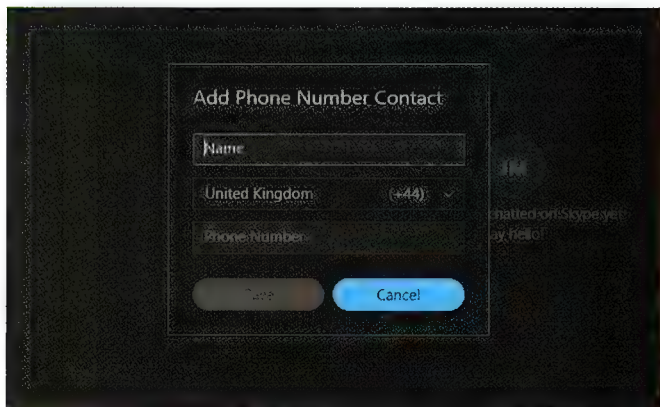
3 VIEW YOUR CONTACTS

Skype is all about staying in touch with people, and to do that, you need to add contacts. The new update makes doing just that even easier. If you use the People app in Windows 10 as an address book, you should see your contacts are already in Skype. You can use the search bar at the top of the app window to easily find who you're looking for.



4 ADD A CONTACT

If you want to add someone to Skype, click the icon of a person with a '+' sign next to them, which is found at the bottom of the window. The latest version of Skype lets you see any mutual contacts you have with people you search for. This makes it easier to identify the right people. Once you've found who you're looking for, click 'Add to Contacts' to add them to Skype.



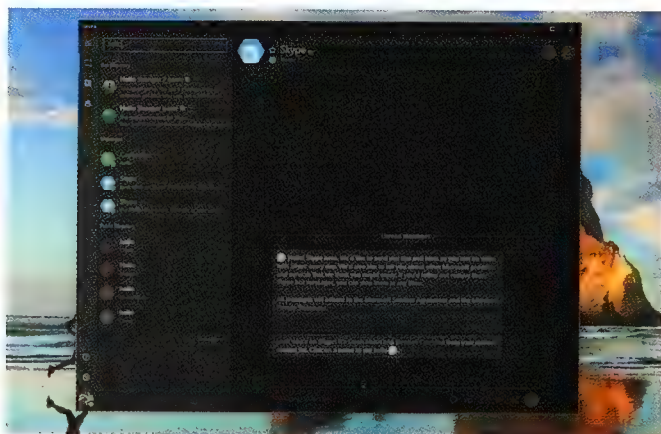
5 ADD A PHONE NUMBER

While you can make video and text calls to other Skype users for free, calls to other landline and mobile numbers cost money. Luckily, you can use Skype Credit to make these calls instead. Skype credits are cheap to top up and use, and cost a lot less than making regular international calls. To add a phone number, click the icon of the telephone with a '+' sign next to it



7 MAKE BETTER GROUP CALLS

Group calls are when two or more people are involved on the same call — making them ideal for virtual business meetings, or big family reunions. The latest Skype update makes group calls even easier — and more fun — than before. To add people to a group call, click on the icon of a person with a '+' sign next to them, then select who you want to join.



9 SEARCH YOUR CHATS

Skype works brilliantly as a free instant messaging program, enabling you to have text chats with contacts around the world. You can even exchange pictures, video and emoticons. For that reason, one of its newest features is a welcome one — the ability to search your messages. To do that, click the Recent Messages icon, then in the Search Skype box, type the phrase you are looking for.



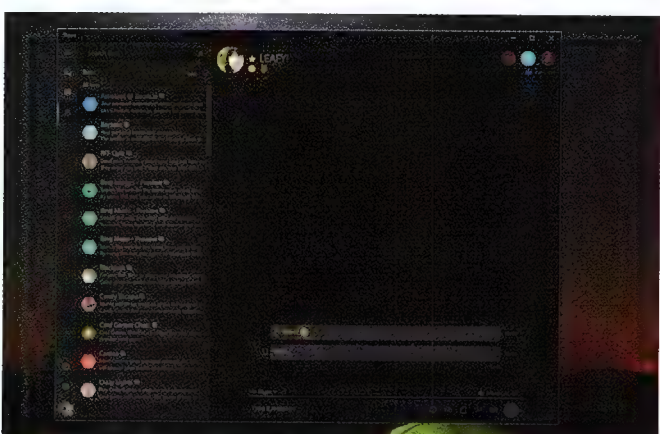
6 SEND A TEXT MESSAGE

One of the most useful features of the new Skype app is the ability to send regular text (or SMS) messages. Again, these are paid for using Skype Credit, but are still cheaper than using your phone when texting people in other countries. To do this, select a Skype contact who has a phone number. Where it says 'Via' in the chat box, select Skype SMS, type in your message and tap Send.



8 EASILY SWITCH BETWEEN DEVICES

Microsoft has worked hard to make Skype an integral part of your life, and one of the ways it has done this is by adding a new feature to the latest version of the app, which lets you quickly and easily switch between devices while on a call. This is great if you're at your desktop PC, but want to switch to your tablet while you move around your home without interrupting your chat.



10 DON'T FORGET THE BASICS

Skype remains an excellent video and voice calling app, and all the features that made it so popular remain. If you want to start a video call, click on the contact you want to call, then on the Camera icon in the top-right corner of the app. To make a voice call, click the telephone icon. Microsoft is dedicated to improving Skype, so keep an eye out for more new features in future! ■

Create a Smart Album in Apple Photos

Become an organisational whizz-kid in Photos with help from Smart Albums and Dave Stevenson.

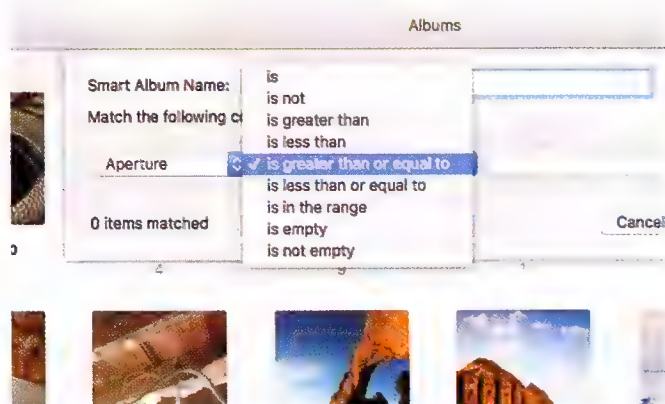
Photos' built-in organisational chops are not to be sniffed at. Face recognition, geotagging and sifting of images into Selfies, Panorama and Live Photos make finding what you want incredibly easy. To organise things further, you'll often find yourself creating Albums. This is fine for

single events – last year's holiday, say, or a wedding lend themselves well to individual albums. You'll find, though, that creating an individual album for a favourite couple of people is pretty onerous – let's say you want pictures of your mum and dad. You'd have to search for one person, then sift through for the pics you

actually want.

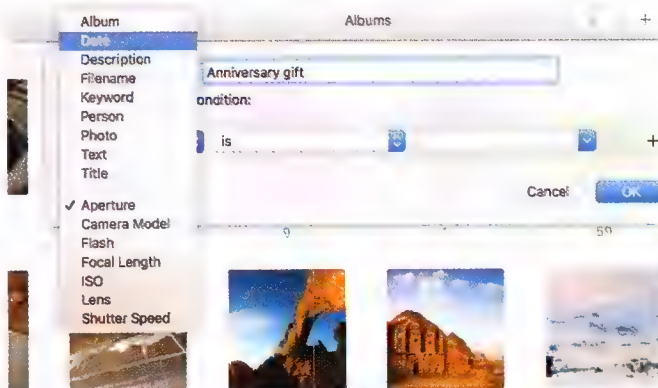
Smart Albums are the answer – you can filter your entire photo library using a very wide selection of filters that will instantly find the photos you want – and keep the new album automatically updated as you add new shots. Here's how to use it.

How to Create a Smart Album



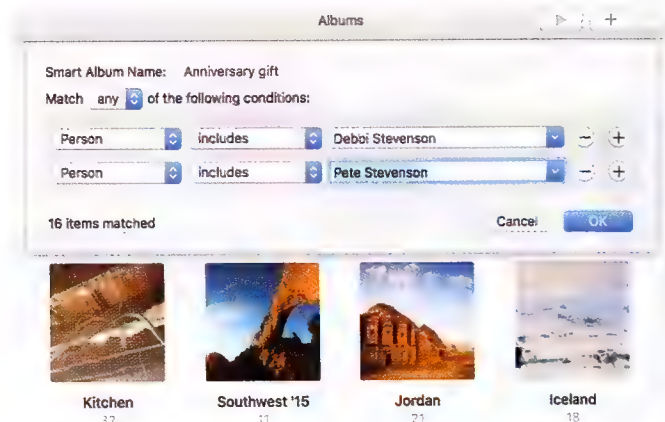
1 NEW ALBUM

To create a new Smart Album in Photos, go to 'File > New Smart Album', or click the '+' in the toolbar and choose 'Smart Album'. Alternatively, press Option-Command-N to bring up the New Smart Album dialog box.



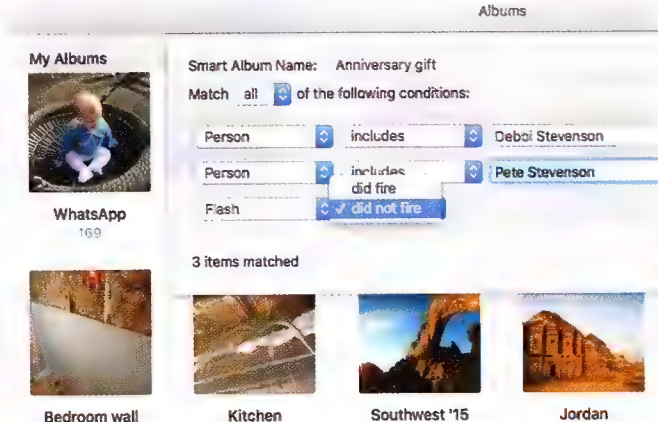
2 MORE CONTROL

While the general options enable you to look for certain criteria (people, types of camera and so on), the 'Is/Is not' dropdown box really allows you to drill down for more finite control of what you might be searching for.



3 CONDITIONS

'Photo' is the default selection but, as you can see, the number of conditions you can choose from is extensive. You can even sort by factors such as Focal Length, Aperture, ISO or Shutter Speed.



4 NAMES

In this case, we're trying to build a list of images for a wedding anniversary gift, so we'll start by naming two people we want to appear in every photo. Each line can only have one variable in it, so click the '+' sign to add the other person.

Smart Album Name:

Match **all** of the following conditions:

Person	includes	Debbi Stevenson
Person	includes	Pete Stevenson
Flash	did not fire	

8 items matched Cancel

elated

5 FLASH-FREE For this example, we're actually only interested in images that have been taken outdoors, so we've added a Flash category to our criteria and selected 'Did Not Fire' so that the album will be limited to flash-free shots.

People ▶ + ⌵

Smart Album Name:

Match **all** of the following conditions:

Person	includes	Debbi Stevenson	⌵ ⌵
Person	includes	Pete Stevenson	⌵ ⌵
Flash	did not fire		⌵ ⌵
Camera Model	does not include	iPhone 3GS	⌵ ⌵
Camera Model	does not include	iPhone	⌵ ⌵
Camera Model	does not include	iPad	⌵ ⌵
Camera Model	does not include	KeyMission 360	⌵ ⌵

0 items matched Cancel OK

6 AUTO UPDATE Each time you add a condition, the number of images in the album updates automatically. We'll be importing more images to Photos after the Smart Album is created so the small running total is not a problem.

Screenshots

Recently Dele...

Anniv...

Whats...

Twitter

Snapc...

Posts...

Instag...

Blimey

Crikey

Bedroom wall

Kitchen

Southwest '15

Jordan

Iceland

Yellowstone

Puffins

Play Slideshow

Edit Smart Album

Duplicate Smart Album

Rename Smart Album

Delete Smart Album

Sort



[Confirm Additional Photos](#)

[Unfavorite This Person](#)

[Add to Memories](#)

7 EQUIPMENT Here, refine the search to exclude certain older phones and compact cameras — useful if you're aiming for a level of quality. The dropdown box is automatically populated with all the different camera models found in your Photos library.

Live Photos

Panoramas

Time-lapse

Slo-mo

Bursts

Screenshots

Recently Dele...

WhatsApp

Twitter

Snapchat

Postsnap

Instagram

Blimey

Crikey

Bedroom wall

Kitchen

Southwest '15

Jordan

Iceland

Yellowstone

iPhoto Events

Arizona

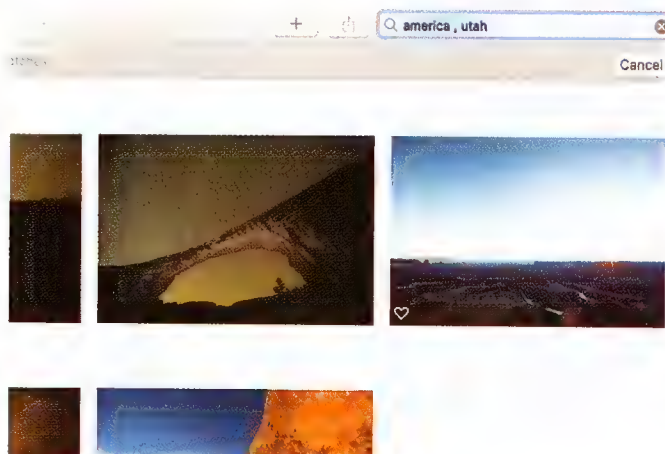
Gorillas

Yellowstone

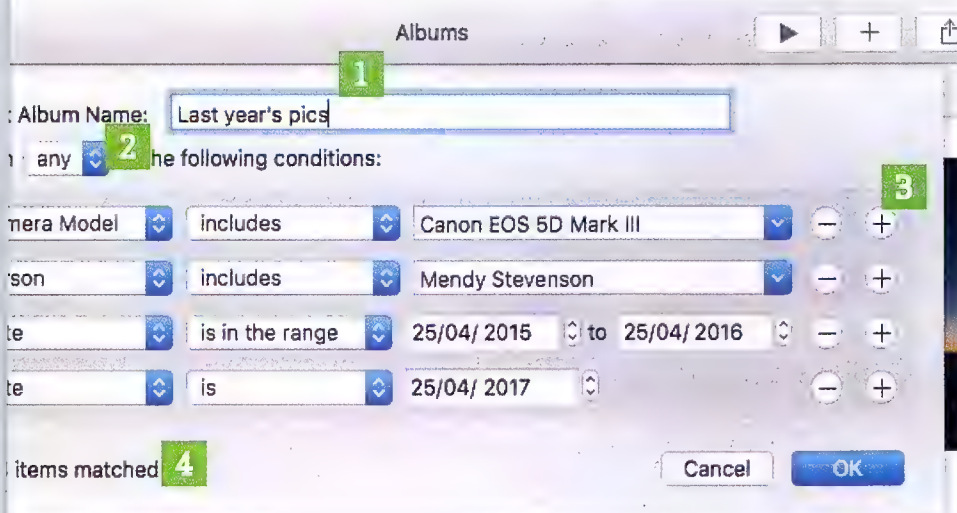
Iceland

Arizona

Puffins



8 LATER EDITS Hit OK and your album is created and automatically filled with images. To make changes later, Control-click the album name and choose 'Edit Smart Album' — this is handy if you realise certain images are being missed.



Jargon buster

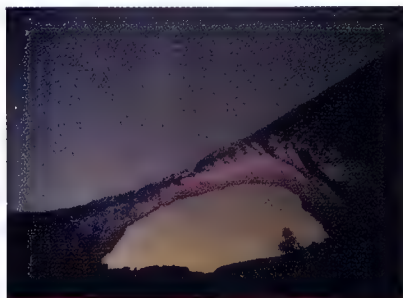
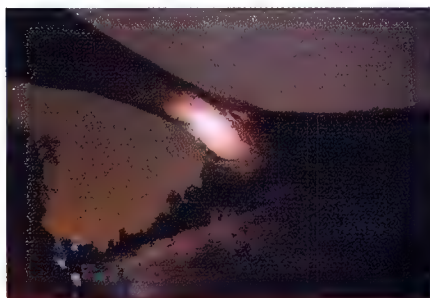
'Keywords' is the name Photos uses for what some other apps called tags — individual words that describe what your images contain. Smart Albums let you filter by multiple keywords.

1 SMART NAME Give your Smart Album a smart name. If you use this feature a lot, you'll have loads of albums, so give them descriptive names you can tell apart.

2 SETTING RULES This one's important if you have a Smart Album with multiple rules. By default, Photos will find all photos that match any of your rules. If you only want the shots that match them all, say so here.

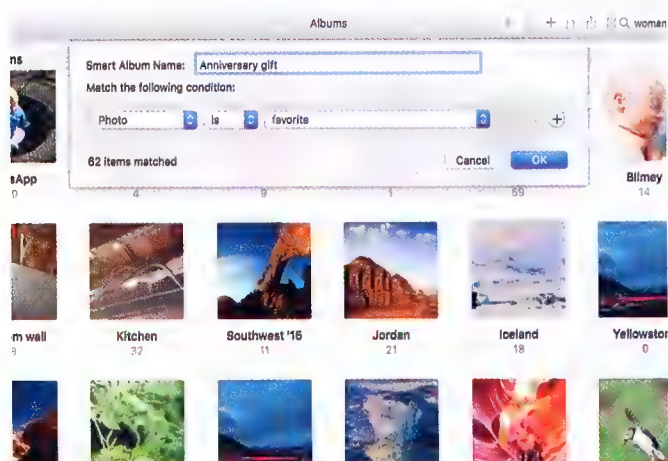
3 DEFAULT RULE The default Smart Album screen allows you to set a single rule. If you want more, hit the '+' sign to create another.

4 REFINING RULES If it looks like your Smart Album is going to contain hundreds of shots, you could consider refining your rules a little more.

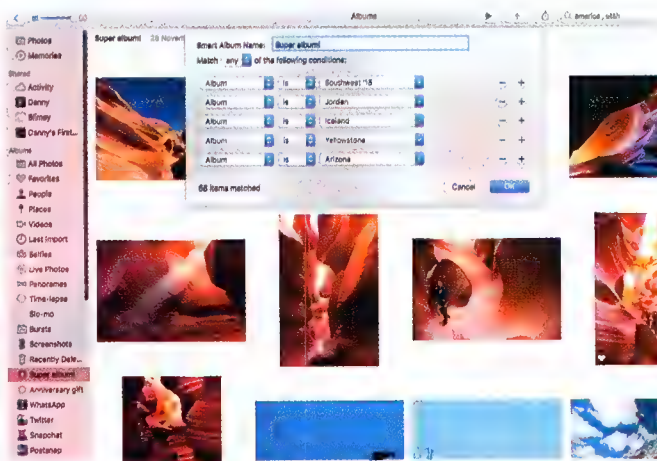


Genius tip

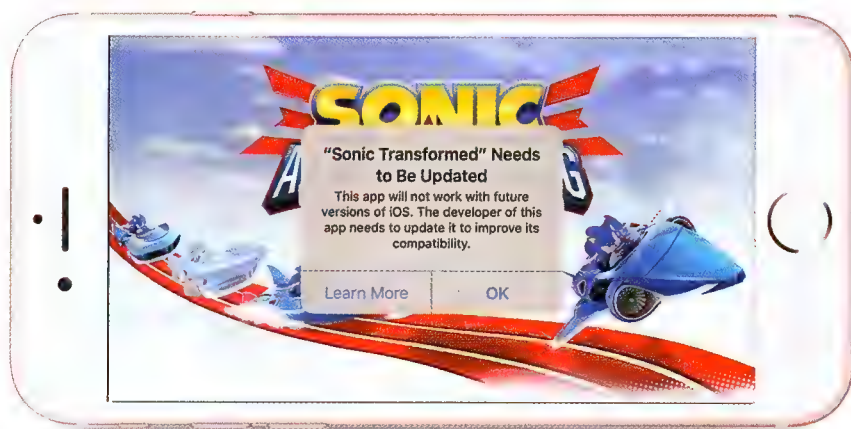
One of the best, simplest ways to use Smart Albums is to create a set of photos taken by a single camera — voila! all your shots taken with your 'proper' camera in one place.



9 KEYWORDS Unfortunately, you can't type in multiple keywords and use them as variables. If you want to do this, enter multiple keywords in Photos' standard search box, then add another single keyword that will definitely be picked up by your Smart Album.



10 SUPER ALBUM Here, we've decided to put together a 'super album' using photos from a selection of different travel albums. If we then add Favourites as one of the conditions, the album will be a blast to browse through.



Prepare your iPhone for the iOS 11 update

Alan Stonebridge discovers which of your apps won't work in the next iOS — so you can replace them.

After updating your iPhone or iPad to iOS 10.3, opening certain apps and games may have presented you with a warning that they need to be updated to work with future versions of iOS. You can keep using them with iOS 10, but if you plan to upgrade to iOS 11 (expected to be released in September), now is the time to take action for any apps you depend upon.

You need to find out which of your apps are affected. Expect many of them to be games, which you may still enjoy playing, but it's more in the case of productivity apps that you should be

concerned about; if you're dependent on any of those apps and plan on using iOS 11, you'll need to find replacements. For example, if you've got important documents prepped up, you don't want to lose access to them.

There's no need to laboriously open each app to discover which of them will definitively be incompatible with the next iOS, though. In addition to the warning upon opening an app, iOS 10.3 can show you a list of all affected apps that are currently installed. Note, though, that it won't tell you about apps you've deleted to make room for something else.

REDOWNLOAD FIRST

So before following the steps below, and assuming your device has enough space, redownload apps you may want to use again: open the App Store and tap Updates followed by Purchased.

If you've disabled auto-downloading of apps in 'Settings > iTunes & App Stores' on any of your devices, you'll need to follow this tutorial on each device to be certain you aren't overlooking an app that's on your iPhone, say, but not your iPad.

How to Check apps for updates or replacements

< About App Compatibility

These apps may slow down your iPhone and will not work with future versions of iOS if they are not updated. If no update is available, contact the app developer for more information.

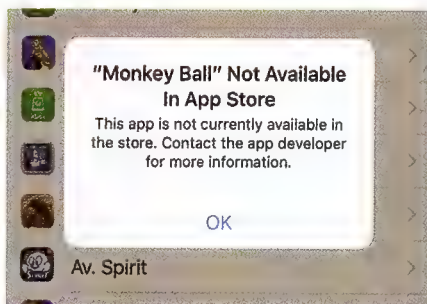
NO UPDATES AVAILABLE

Monkey Ball

Jet Set Radio

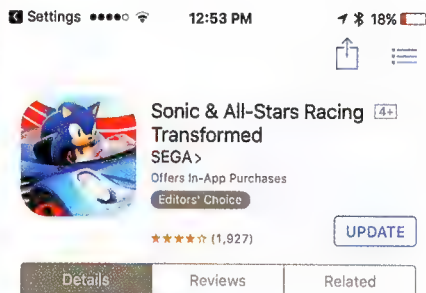
1 CHECK THE LIST

In 'Settings > General > About', if there's no arrow at the right of the Applications row, none of your apps require immediate action (though that's no guarantee they won't have other issues). If there is an arrow at the top of the row, tap it.



2 CHECK FOR UPDATES

Tap an app's row to go to its store page, if it's still there; you may see an Update button if you've disabled auto-updates in 'Settings > iTunes & App Store'. If there's an update, download it and see if iOS flags up its compatibility.



3 ASK THE DEVELOPER

If the app's delisted, check if an upgrade is available as a new purchase: search for the developer's name in the App Store. Failing that, ask directly through its website if there are plans for an update or a replacement app.

Set up and configure iOS 10's Bedtime feature

Alan Stonebridge ensures you get some quality shut-eye.

You may think you know about every single way you can use the Clock app, but in iOS 10, it has gained a new feature, Bedtime, that's well worth checking out. As its name suggests, it's all about helping you get a good night's rest, and it'll also give you some insight into your sleep patterns.

Tap Bedtime's icon in the centre of the app's bottom bar and you'll be asked a few questions, one at a time, such as how many hours sleep you need, when you want to be woken up and how far in advance you want your device to prompt you to get ready for bed. The last of these can be set to occur up to an hour before bedtime, enabling you to attend to the day's final tasks, or you could treat it as a prompt to set aside devices that may be keeping your mind active.

If you already make use of the Clock app's Alarms feature, rest easy in the knowledge that instructions you give to Siri, such as "Delete all of my alarms" and "Turn off my alarms", don't affect Bedtime's wake-up call.

In contrast to alarms, Bedtime offers a more gentle selection of sounds to rouse you from your slumber – so gentle that, until you've tried it out for at least a few days, to ensure your pick of sound effect and volume are effective, we recommend you keep a regular and more boisterous alarm set for shortly after Bedtime's wake-up call to ensure you don't end up being late for work.

COMPLEMENTARY FEATURES

Once you've set up your bedtime schedule, it's worth complementing it with iOS's Do Not Disturb and Night Shift features. The former ensures

only essential communications get through to you between certain hours; go to 'Settings > Do Not Disturb' to configure when it's active, and optionally to allow a group of people you've set up in the Contacts app to get through to you anyway – useful for relatives or if your job requires you to be available on call, say.

Meanwhile, Night Shift reduces the amount of blue light output by your device's screen so that it's warmer, ostensibly to help you relax late in the day. To set it up, go to 'Settings > Display & Brightness'. The effect will appear extreme when you enable it for the first time, but you'll grow accustomed to it after a few days, after which, disabling it (from Control Centre) will make the colder, blueish output appear harsher than you may remember late at night.

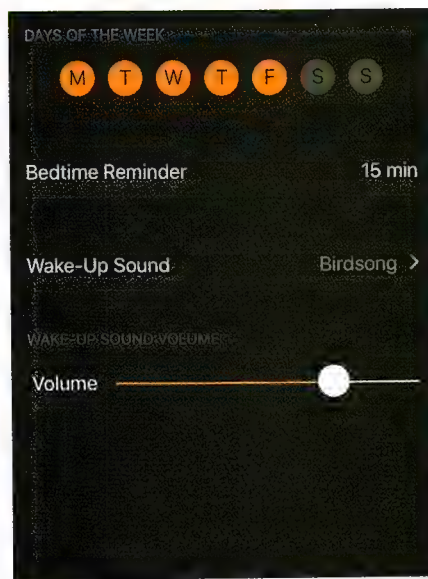
How to

Manage and monitor your sleep patterns



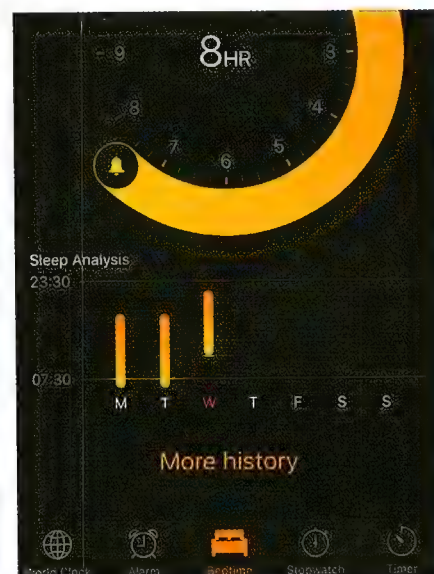
1 SLEEP AND WAKE TIMES

After running through Bedtime's initial set-up steps, its page shows a switch that toggles it on or off. When on, drag the alarm and moon icons on the clock face to set bed and wake times; your sleep's expected duration is shown in the middle.



2 SCHEDULING AND SOUNDS

Tap Options to set days on which the feature is active and how long before you'll be reminded to wind down. You can pick the sound that'll wake you, the volume it'll build up to, and have your iPhone vibrate, too (vibrate-only is also an option).



3 REVIEW YOUR REST

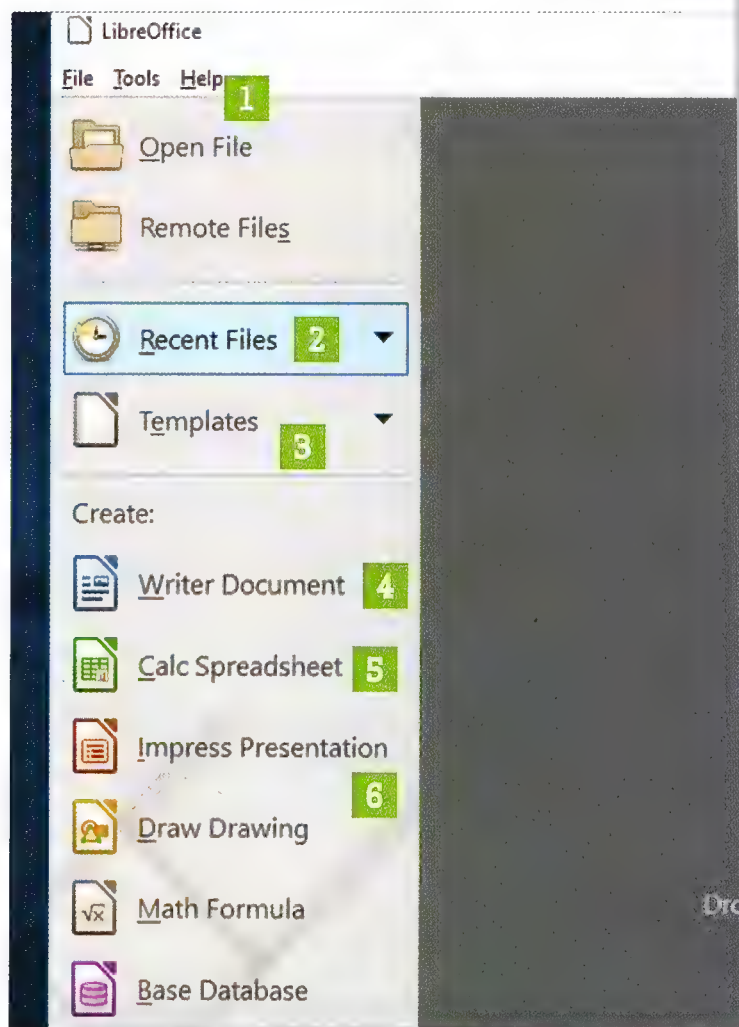
With your iPhone next to you, it'll analyse your movements. The current week's sleep is visualised at the bottom of the page; tap 'More history' to look further back and correlate with data from accessories or entered manually. ■

How to switch to LibreOffice

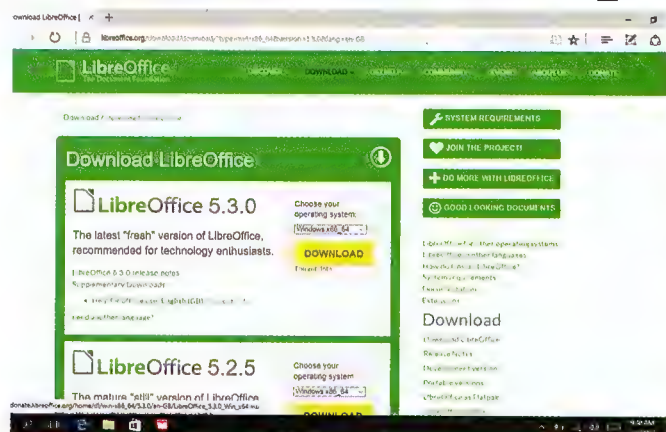
Nate Drake shows how to create Microsoft-compatible presentations, spreadsheets and documents with this office suite.

Microsoft Office is a fantastic productivity suite but also takes up a lot of space, resources and you have to pay for it. LibreOffice is the free and lightweight alternative. Most importantly, it's fully compatible with MS Office so you can both open and save in the Microsoft Word, Excel and PowerPoint formats. Use the fantastic word processor, Writer, to create professional-looking documents. You can also create and manage your finances with the spreadsheet software, Calc. The handy program Impress can also be used to create brilliant, animated PowerPoint-style presentations.

This guide focuses on the basic steps to download and install LibreOffice as well as opening documents. Also feel free to visit <https://www.libreoffice.org/get-help/> community-support, which features help guides for individual apps and the LibreOffice Wiki.



Take your first steps with LibreOffice



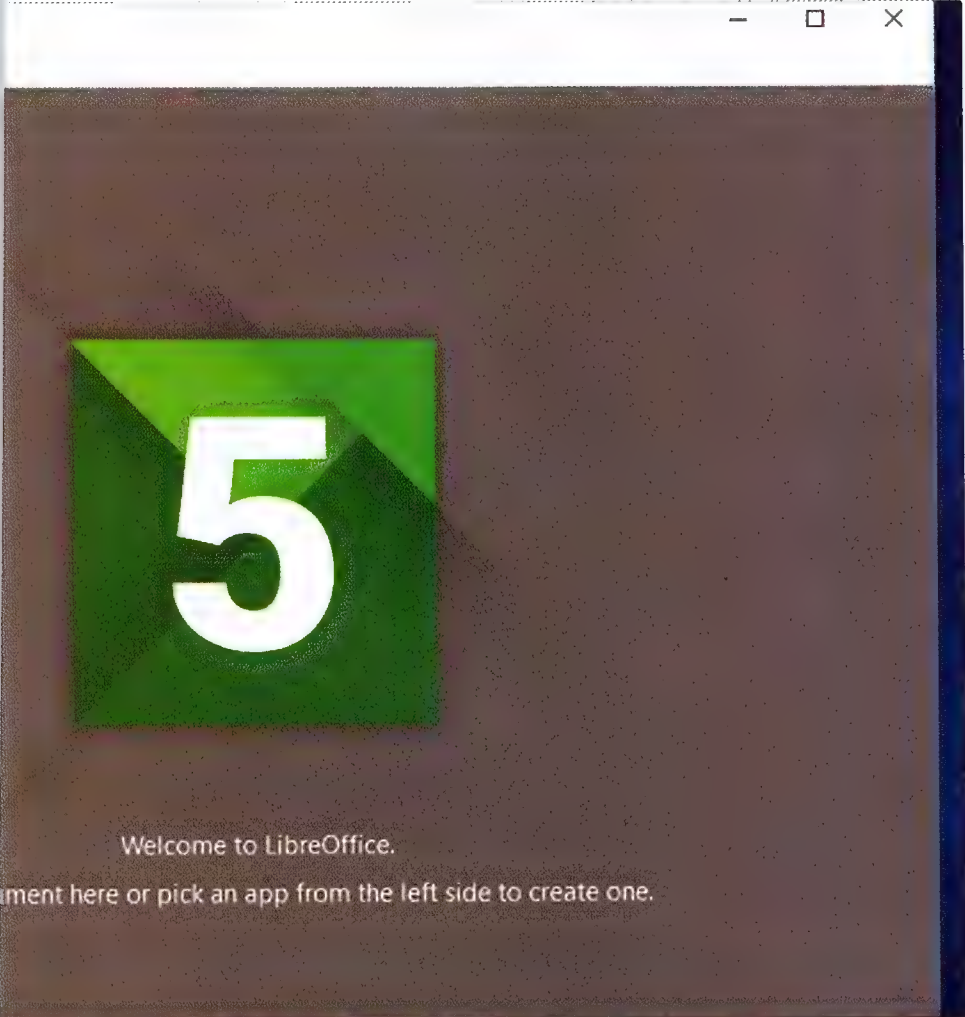
1 DOWNLOAD LIBREOFFICE

Open your browser and go to [libreoffice.org/download](https://www.libreoffice.org/download). The default download options should be fine, but click on 'Choose your Operating System' if you want to change them. The default language is US English. If you want to change this to British or Australian English (we do), click on 'need another language' and select it from the list. Then select 'Download'.



2 SAVE AND LAUNCH THE INSTALLER

Your browser of choice will now ask what to do with the installation file. Click on Save to begin the download. The file is quite small (around 200MB) so this won't take long. If you're using Microsoft Edge, click Run once the download has finished to launch the installer. For other browsers, you may need to open the downloads folder and double click the installer from there.



1 OPEN FILE

Click here to open File Explorer. LibreOffice can open Microsoft Office documents as well as its own ODF files.

2 RECENT FILES

LibreOffice keeps a record of files that you have recently worked on in the app. Click here to display a list of them.

3 TEMPLATES

Click the black arrow to display templates for individual apps such as Writer. These will appear inside the main window.

4 WRITER DOCUMENT

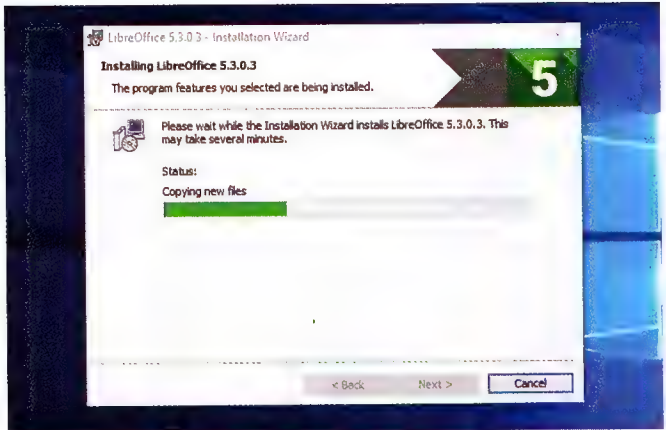
Click to create a new Writer document for word processing. Files can be saved in Word (.docx) format.

5 CALC SPREADSHEET

Click to create a new, blank spreadsheet. Spreadsheets can be saved in Excel (.xlsx) format for sharing with other users.

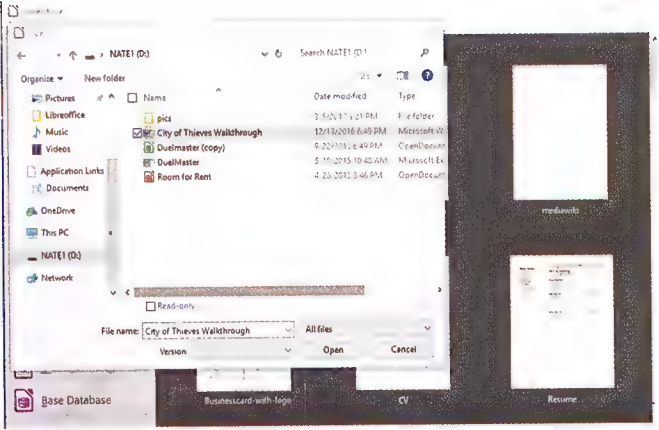
6 IMPRESS PRESENTATION

Click here to create a new presentation. It can be saved as a PowerPoint (.pptx) file for compatibility.



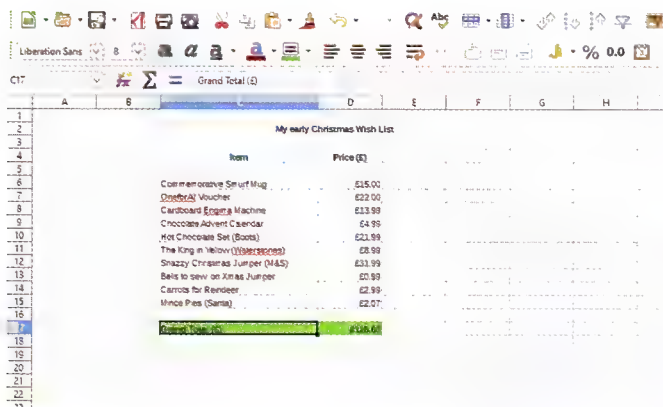
3 FINISH THE INSTALLATION

Once the LibreOffice installer launches, click Next to continue. You can now choose the Installation type. Leave 'Typical' checked (you can always change this later) and click Continue. On the next screen, click the checkbox to have LibreOffice launch on startup then click Install. Windows will ask you to confirm that you want to make changes. Click Yes and the install will complete.



4 OPEN DOCUMENTS IN LIBREOFFICE

You should now see a shortcut for LibreOffice on your desktop. Double click this to open the main window. Open a Microsoft Office document to familiarise yourself with the app. Click on 'Open File', then navigate to your file of choice. Click Open. The corresponding app for your file will launch automatically. Here, the Microsoft Word Document opens in Writer.



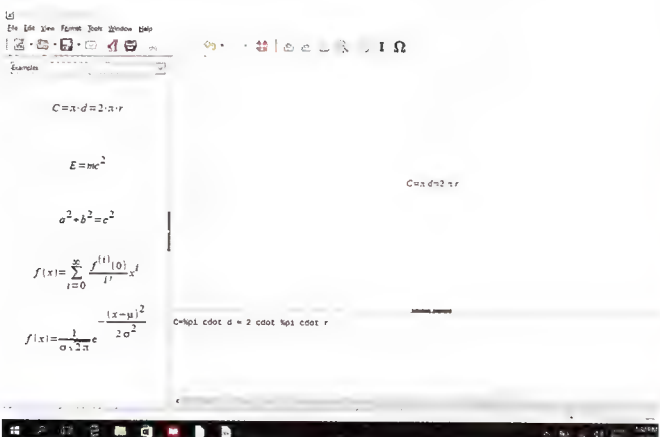
5 CREATE A NEW LIBREOFFICE DOCUMENT

Close your document and relaunch LibreOffice from your desktop. Note the document you just opened is now listed under 'Recent Files'. You can double-click to reopen files you're working on at any time. For now, look at the Create section of the main window and click one of the options, such as Calc Spreadsheet, this will create a new, blank document for you to work on.



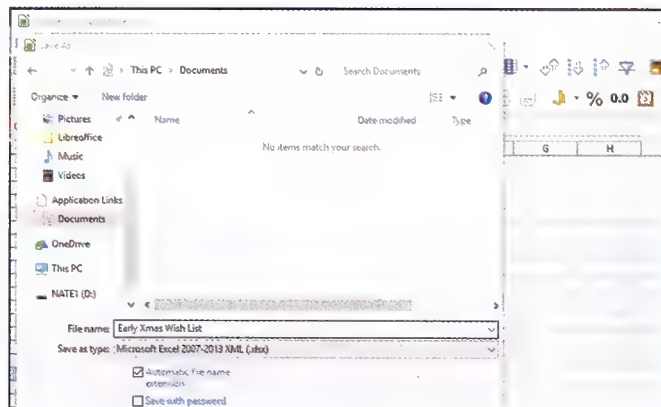
7 USE TEMPLATES

Rather than creating a document from scratch, LibreOffice includes templates to get you started. Launch LibreOffice again and click the arrow besides Templates to view categories such as those for presentations. Double-click your chosen template to load a new document based on it. Use Manage Templates to add and remove categories as well as to make your own templates.



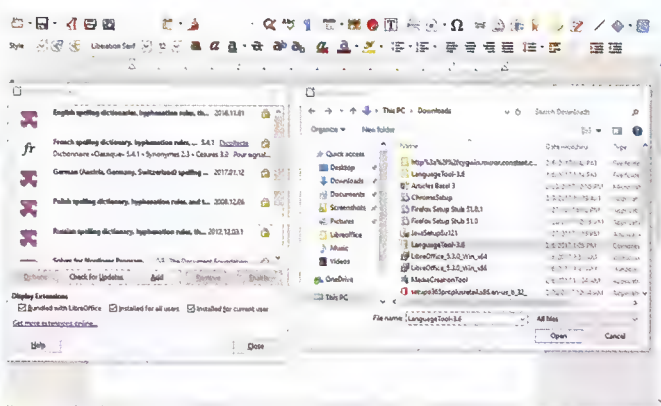
9 OTHER LIBREOFFICE APPS

So far, we've focused on word processing, spreadsheets and presentations. LibreOffice has other powerful apps however. Draw enables you to create graphics and diagrams. Math is used to work with formulae. Both of these work as standalone apps or can be launched from inside others. The handy app, Base, allows you to create and edit databases, much as Microsoft Access does.



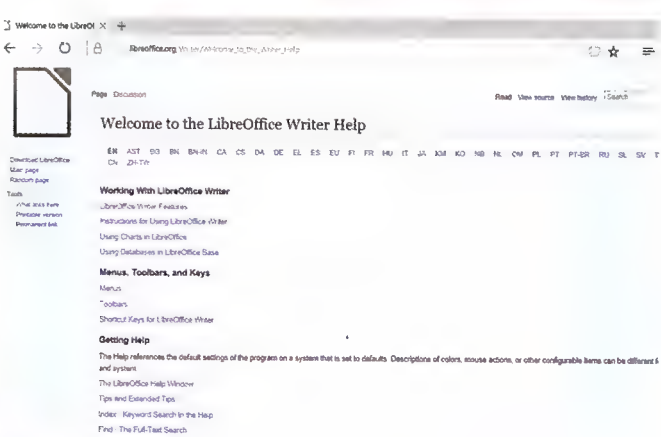
6 SAVE A DOCUMENT

Once you've changed your document to your satisfaction, it's time to save it. Click the Save icon at the top left or choose 'File... Save As'. Choose a filename. Under 'Save as Type', you'll see that LibreOffice wants to use its own (.odf) format. If you want to share this document with MS Office users, click this menu and choose a Microsoft format (such as .xlsx). Click Save to confirm.



8 ADD LIBREOFFICE EXTENSIONS

Open your browser and visit extensions.libreoffice.org to view all available add-ons. Here, we're installing the Language Tool, which checks your grammar. Click the link to download and save the file. Next, open LibreOffice and go to 'Tools > Extension Manager'. In the new window that appears, click Add, navigate to the new file and click Open to install.



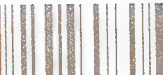
10 HOW DO I...?

This is only a brief introduction to LibreOffice. Visit the Community Support portal (<http://bit.ly/2nMDoxI>) for further help. Or press 'F1' at any time when using LibreOffice to be redirected to the relevant help page. One handy tip is to start with the Features section to see if the function you want is supported. It often is, but you access it in a different way than in MS Office.



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Build your own Linux-powered darknet

Nate Drake has a secret to share: he can help you set up and run your own private darknet website, which only you and your friends can access.

Almost anyone can set up a 'hidden service' on the darknet using Tor. This involves setting up a server using the software Apache2 and generating a '.onion' address so that other Tor users can connect.

By default, anyone in possession of the address, such as `www.facebookcorewwi.onion`, can connect to a Tor hidden service.

For big sites such as Facebook, there's no harm in doing things this way, because everyone knows who owns the website, and their business model thrives on people connecting and sharing data.

For private citizens in Australia, who are now subject to metadata collection including monitoring of all web traffic, the very fact that you've downloaded server software must now be recorded by your ISP, as is the fact you're using Tor in the first place.

This means that setting up a Tor hidden service anonymously is extremely tricky. Even once you have it up and running, other people connecting to it risk that one of Tor's nodes has been compromised and will record that '.onion' address.

Malicious web crawlers such as PunkSPIDER have even been able to map the entire Tor darknet, checking hidden services for vulnerabilities. This in itself is not a major security concern, because knowing the address of a website is only the first step to hacking into its server. However, if you only want to share information with a limited group of people, there is a way to prevent rogue scanners from connecting automatically to your hidden service and discovering your server's real IP address.

STEALTHY ONIONS

This is done using 'stealth' onion services. In brief, the way this works is that you generate a unique .onion address for each individual user of your website, in addition to an authentication 'cookie'.

In order to connect to your Tor hidden service, users need both this unique .onion address and the cookie. Any other person or service simply sees a message saying that it failed to connect.

The steps in the tutorial cover generating unique authentication cookies and onion addresses for your contacts. You need to help them configure their Tor Browser Bundle on computer and/or mobile device to store the cookie, so they can access your service. You do this by modifying the 'torrc' configuration file inside their Tor software of choice.

SUPER TAILS

For this project, we're using TAILS (The Amnesiac Incognito Live System). This OS has been designed with privacy in mind. All connections are routed through the Tor network, so there's less danger of leaking your real IP address.

TAILS is designed chiefly for internet users who want to access the darknet by booting from a USB or DVD, and loading into your RAM memory. The advantage of this is that, after the machine restarts, there's no trace left of your internet activity.

The downside to this, of course, is that there is data you may want to save, such as passwords and email addresses. For this reason, TAILS comes with an optional 'persistent' mode when installed on USB stick to store such data.

The Persistent section is encrypted and you need to set a password to unlock it each time you boot TAILS. Follow the steps in the section 'Setting Up TAILS' to do this.

Your website and any associated files are stored safely inside the Persistent section. This hugely increases the physical security of your server, because the drive is encrypted and you can easily remove or destroy it.

LIGHTWEIGHT SERVER

Tor can work seamlessly with a variety

of server software. This project focuses on Nginx-light, which, as the name suggests, is a bare-bones version of the more fully featured Nginx. The server software works on the basis of HTTP modules, which support basic websites, but not more advanced features, such as Mail. The tutorial steps work just as well with the full version of Nginx, although increasing your attack surface could make your server more vulnerable.

If you want to have extra features for your server, such as email, simply substitute 'nginx-light' with 'nginx-full' in the tutorial and backup scripts.

GETTING STARTED

TAILS is not designed primarily to work as a server, although there are plans to introduce this as a feature. However, because it's based on Debian Linux, you can install all the programs you need to turn it into one.

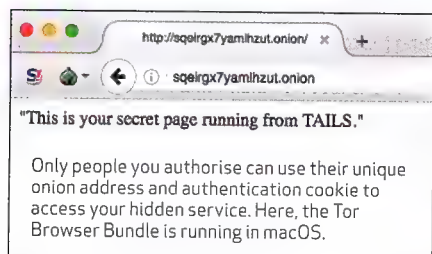
The Debian Project is also good enough to host a mirror of its servers on the darknet. Given the Federal Government's decision to monitor all internet traffic, this is a great relief, because as you'll be installing via Tor hidden services, it's virtually impossible for anyone to tell you're downloading server software in the first place.

Follow the steps in the tutorial to make sure TAILS connects to the darknet using 'bridges'. This makes it harder for your ISP to detect you're running a hidden service.

At this point, TAILS cannot be run headlessly — without a monitor, mouse and keyboard — so make sure to choose a machine you won't need while your hidden service is running. This also means that you need to be present each time TAILS boots up, to enter passwords and restore your data.

The TAILS website says that at least a 4GB USB stick is required to run the OS. Play it safe and choose at least an 8GB one, because hopefully your website will grow over time.

Before following the steps in the tutorial (over the page), note down the people who will be accessing your service and ask each of them either to install the Tor Browser Bundle on their machines and/or Orbot on their Android device.



Backup scripts

To run a server on TAILS, you need to save your software, web pages and client keys so they can be restored if necessary. These are saved in the encrypted 'Persistent' section of the USB stick.

Open Terminal in TAILS, then create a folder to store backups, with `mkdir /home/Amnesia/Persistent/tails-server`. Next run `sudo nano /home/Amnesia/Persistent/backup.sh` and paste:

```
cp /etc/nginx/sites-available/default /home/Amnesia/Persistent/tails-server/
cp /etc/nginx/nginx.conf /home/Amnesia/Persistent/tails-server/
cp /etc/tor/torrc /home/Amnesia/Persistent/tails-server/
cp /var/lib/tor/hidden_service/hostname /home/Amnesia/Persistent/tails-server/
cp /var/lib/tor/hidden_service/private_key /home/Amnesia/Persistent/tails-server/
cp /var/lib/tor/hidden_service/client_keys /home/Amnesia/Persistent/tails-server/
chmod -R 0777 /home/
```

```
Amnesia/Persistent/tails-server/
echo Done.
Save and exit. Make it executable:
sudo chmod a+x /home/Amnesia/Persistent/backup.sh
Run the backup:
cd /home/Amnesia/Persistent
sudo ./backup.sh
Press 'Ctrl-X', 'Y', then Enter to save and exit.
Make the script executable with
sudo chmod a+x /home/Amnesia/Persistent/backup.sh
Use cd /home/Amnesia/Persistent to switch to the Persistent directory, then run a backup with sudo ./backup.sh
To create the restore script, run the command sudo nano /home/Amnesia/Persistent/restore.sh, then paste in the following:
apt-get update
apt-get install -y nginx-light ufw
ufw enable
cp /home/Amnesia/Persistent/tails-server/torrc /etc/tor/torrc
service tor restart
service tor stop
service nginx stop
```

```
cp /home/Amnesia/Persistent/tails-server/default /etc/nginx/sites-available/
cp -f /home/Amnesia/Persistent/tails-server/hostname /var/lib/tor/hidden_service/
cp -f /home/Amnesia/Persistent/tails-server/private_key /var/lib/tor/hidden_service/
cp -f /home/Amnesia/Persistent/tails-server/client_keys /var/lib/tor/hidden_service/
cp /home/Amnesia/Persistent/tails-server/nginx.conf /etc/nginx/nginx.conf
chown -Rv www-data:www-data /var/www/
service tor start
service nginx start
echo Restored.
Save and exit. Make the script executable with sudo chmod a+x /home/Amnesia/Persistent/restore.sh. To test, restart TAILS and run the restore script. Use cd /home/Amnesia/Persistent to switch to the Persistent directory, then restore your server with sudo ./restore.sh.
```

You can always remove or add more users later on if you wish.

SET UP YOUR WEBSITE

The walkthrough outlines how to create a basic index page to let you know the server is working correctly – however, after going to all this trouble, you will probably want more than this.

Tor hidden services can host most kinds of websites, though given that you're running yours from a USB stick, the more lightweight the better. If, for instance, you want to run an imageboard, consider using vichan, which is a fork of the now defunct tinyboard. Refer to each program's project page to see whether any additional software is required, such as MySQL. If so, make sure to modify your 'restore' script (see above) to make sure this can be automatically installed each time you restart TAILS.

LOCK DOWN YOUR SERVER

Once your hidden service is up and running, consider installing a basic firewall by opening Terminal and running `sudo apt-get install ufw`. Once the install is complete, run the command `sudo ufw enable`

to start the firewall. By default, all incoming connections are blocked and all outgoing connections are allowed.

If you want to enable incoming connections on a certain port, use the syntax `sudo ufw allow` – for example, `sudo ufw allow 23`.

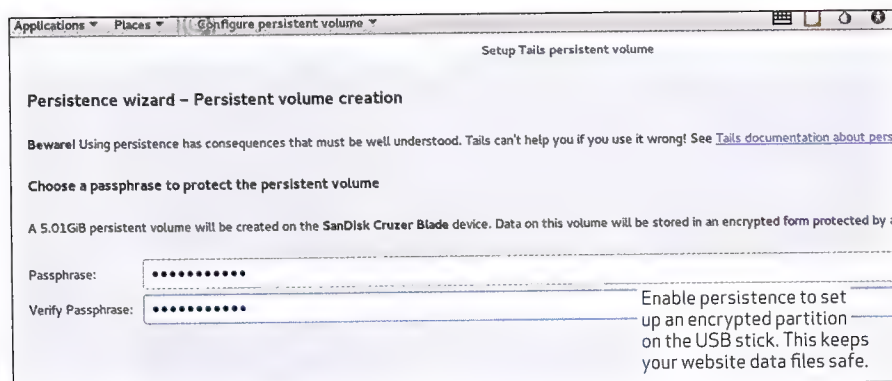
Once all your clients are able to connect to your website, take some time to lock down Nginx properly by running `sudo nano /etc/nginx/nginx.conf`.

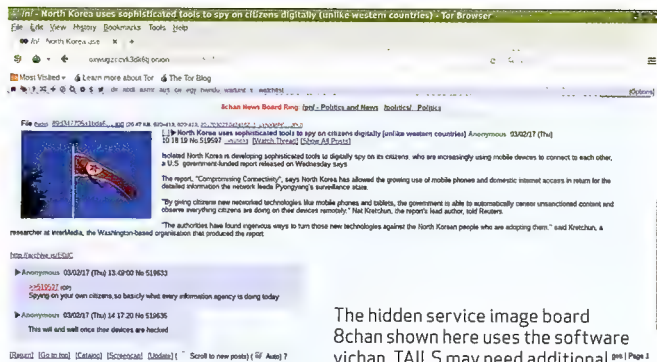
Remove the `#` at the start of the line starting with the words `server_tokens off`. This means that, if an

unauthorised person tries to connect, the fact that you're using Nginx-light won't automatically display. Next, scroll down to the 'Basic Settings' section, and find 'Logging Settings'. Put a `#` before the lines starting `access` and `error`.

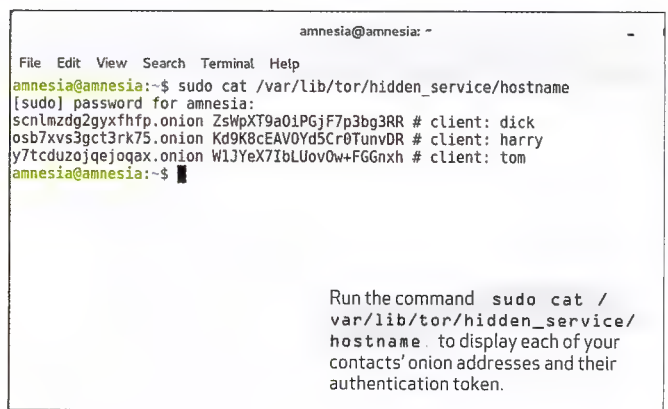
This feature disables most logging features, which makes it more difficult for anyone to identify who is connecting to the server, although any error messages are still logged.

Now restart Nginx to apply your changes with `sudo service nginx restart`.





The hidden service image board 8chan shown here uses the software vichan. TAILS may need additional software to run certain websites.



Run the command `sudo cat /var/lib/tor/hidden_service/hostname` to display each of your contacts' onion addresses and their authentication token.

The 'light' version of Nginx you're using contains a bare minimum of HTTP modules to set up a basic website, although you can add others if you wish. Bear in mind that the more modules you install, the more likely it is an attacker can find one to exploit.

TAILS OF WOE

By its very nature, TAILS is amnesiac. If you remove the USB stick from your computer or restart the machine itself, all files and settings are lost.

For this reason, make sure you've enabled persistence by following the steps in 'Setting Up TAILS' (see below) before going through the tutorial.

Once you're happy that your darknet site is up and running OK, make sure to go through the 'Backup Scripts' section (see previous page) so that you can save and reload your settings.

The Riseup website (<https://riseup.net/en/security/network-security/tor/onionservices-best-practices>) contains

some excellent advice for best practices with Tor hidden services. Pay close attention to the section on local host bypasses. And make sure you keep your software up to date, because new vulnerabilities are discovered with TAILS and Tor hidden services all the time.

That said, remember that Tor supports a number of hidden services, so don't be afraid to experiment with running a private mail server or chat service, as opposed to a simple web page. A good security approach is to think of the authentication token as being only one layer of protection, and you can require users to log in with a separate password to your site.

Also, remember that, if anyone can access your machine while TAILS is running, they may also be able to access your client tokens.

The only safe way to make sure that only people you approve can access your hidden service is if you give them their

keys in person. Remember that anyone with access to their device can either use the hidden service or make a copy of the authentication token. Ask them to store their Tor Browser on an encrypted drive. Mobile users should also enable encryption on their Android device, in case of theft or seizure.

If you are worried your keys have been compromised, run the command `sudo shred -v /var/lib/tor/hidden_service/client_keys` and restart Tor with `sudo service tor restart`. The system will generate new keys for your users.

Finally, bear in mind that, while malicious scanners won't be able to automatically connect to your hidden service, they won't receive the same message they would for an invalid onion address — in other words, they will know the address exists, but it will appear as though the server is down. This isn't exactly plausible denial but the Tor Project is working on it.

Setting up TAILS

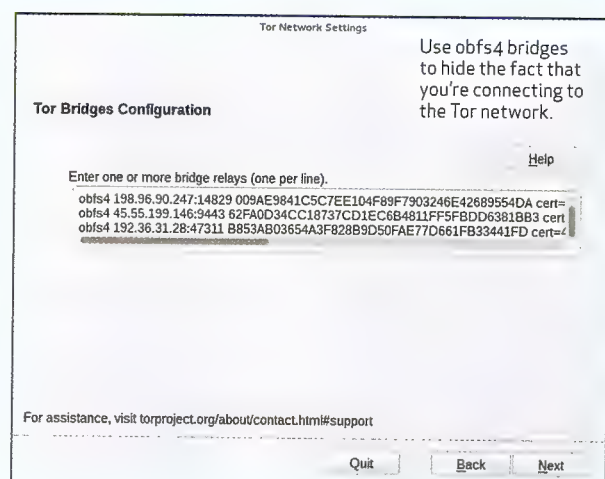
This project is designed to boot from the OS Tails, installed on USB. Follow the steps outlined on the TAILS website at <https://tails.boum.org/install/index.en.html> to do this.

The USB stick must be at least 4GB in size (we recommend 8GB). Once installed, restart your machine and boot from USB. You may need to change your BIOS settings to do this. Click Yes on 'More Options', and type an admin password.

By default, anyone monitoring outgoing connections made by TAILS will be able to see you're using Tor. You can make Tor traffic much harder to detect by visiting <https://bridges.torproject.org/options> and choosing 'obfs4' under 'Advanced Options' to get some bridge addresses. Inside TAILS, click on 'This Computer's Connection is Censored', then 'Configure > Yes > Next'. Paste in the bridge addresses.

In TAILS, by default, all data is lost when you restart your machine. You can create an encrypted volume, however, to store files and settings. Once the desktop loads, click 'Applications > Tails > Configure Persistent Volume'. Choose a strong passphrase and click Create. The wizard asks you which data to save — make sure Apt Packages, Apt Lists and Dotfiles are ticked, then click Save.

Restart TAILS to enable persistence fully. On the boot screen, click Yes on 'Use Persistence?' and enter your new password.



Click Yes again for more options and Forward to choose an admin password like before. Follow the steps in the 'Backup Scripts' section (back over the page) to save and restore your server settings.

Set up your darknet site

```
amnesia@amnesia: ~  
File Edit View Search Terminal Help  
GNU nano 2.2.6 File: /live/persistence/TailsData_unlocked/persistence.conf Modified  
/home/amnesia/Persistent source=Persistent  
/etc/NetworkManager/system-connections source=nm-system-connections  
/var/cache/apt/archives source=apt/cache  
/var/lib/apt/lists source=apt/lists  
/home/amnesia source=dotfiles,link  
/var/www source=www
```

1 CONFIGURE THE SERVER FOLDER

Follow 'Setting Up TAILS' to boot from a USB stick and set up persistence. Open Applications > Terminal, run `sudo mkdir /var/www`, then `sudo mkdir /live/persistence/TailsData_unlocked/www`. Edit the persistence config file with `sudo nano /live/persistence/TailsData_unlocked/persistence.conf/` and add the line `/var/www source=www` at the end. Press 'Ctrl-X', then 'Y', then Enter to save and exit. Reboot TAILS, open Terminal and run `sudo apt-get update`, then `sudo apt-get install nginx-light`. Run `sudo nano /etc/nginx/sites-available/default`, paste the text in Step 2 at the end, save and exit.

```
amnesia@amnesia: ~  
File Edit View Search Terminal Help  
GNU nano 2.2.6 File: /etc/tor/torrc Modified  
##### This section is just for location-hidden services ###  
## Once you have configured a hidden service, you can look at the  
## contents of the file ".../hidden_service/hostname" for the address  
## to tell people.  
##  
## HiddenServicePort x y:z says to redirect requests on port x to the  
## address y:z.  
##  
HiddenServiceDir /var/lib/tor/hidden_service/  
HiddenServicePort 80 127.0.0.1:8080
```

3 SET UP STEALTH SERVICES

Run `sudo nano /etc/tor/torrc`. Scroll down to 'this section is just for location-hidden services'. This is where you'll set up a hidden service for each user. Modify the names in the last line before pasting:

```
HiddenServiceDir /var/lib/tor/hidden_service/  
HiddenServicePort 80 127.0.0.1:8080  
HiddenServiceAuthorizeClient stealth  
tom,dick,harry  
Save and exit.
```

```
amnesia@amnesia: ~  
File Edit View Search Terminal Help  
GNU nano 2.2.6 File: /var/www/index.htm  
"This is your secret page running from TAILS."
```

5 SET UP CLIENT ACCESS (TOR BROWSER)

Run `sudo cat /var/lib/tor/hidden_service/hostname` to list access tokens for all users. Ask your user to open their Tor Browser Bundle folder and use a text editor to open the file 'torrc'. This is found in `~/[path_to_tor_browser]/Browser/TorBrowser/Data/Tor/torrc` on Linux. Type the word `HiddenServiceAuth`, then paste the line for their Hidden Service Authentication address and cookie at the end.

```
GNU nano 2.2.6 File: /etc/nginx/sites-available/default  
server {  
    listen 127.0.0.1:8080 default_server;  
    server_name localhost;  
    server_tokens off;  
    root /var/www;  
    index index.html index.htm;  
    location / {  
        allow 127.0.0.1;  
        deny all;  
    }  
}
```

2 SET UP A WEB SERVER

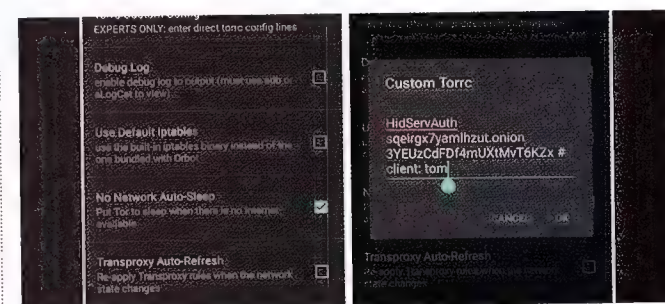
```
server {  
    listen 127.0.0.1:8080  
default_server;  
    server_name localhost;  
    server_tokens off;  
    root /var/www;  
    index index.html index.htm;  
    location / {  
        allow 127.0.0.1;  
        deny all;  
    }  
}
```

```
amnesia@amnesia: ~  
File Edit View Search Terminal Help  
GNU nano 2.2.6 File: /var/www/index.htm  
"This is your secret page running from TAILS."
```

4 CREATE AN INDEX PAGE WITH PERMISSIONS

Create a simple landing page for your website with `sudo nano /var/www/index.htm`. Type in some text such as 'This is your secret page running from TAILS', then save and exit. Give the www user ownership of the `/var/www` folder with `sudo chown -Rv www-data:www-data /var/www`. Restart Tor and Nginx with:

```
sudo service tor restart  
sudo service nginx restart
```



6 SET UP CLIENT ACCESS (ORBOT)

If your contacts prefer to use a mobile, ask them to install the apps Orbot and Orweb on their Android device. Next, start Orbot and go to Menu > Settings > Torrc Custom Config. Type the word `HiddenServiceAuth`, then leave a space and paste in their entry from 'hostname'. They can now access your hidden service using the Orfox browser.

Sculpt 3D models with virtual clay

Get your hands digitally dirty with Sculpttris and Alex Cox.

There are plenty of ways to be creative in the 3D realm, but few of them emphasise the creativity part of the equation as well as Sculpttris does. Made by developer Pixologic – the company behind high-end 3D modeler Zbrush – it is, as its name suggests, primarily focused on sculpting. You're given a big ball of digital clay, then you can poke, prod and pull it into just about any shape you like. Obviously, being based on a malleable, tangible material, Sculpttris is best used to create organic shapes and creations; slashing out the slick lines of a high-end sports car is going to be rather difficult.

It's not flawless, either. There will be times when you push your clay outside the realms of normal three-dimensional physics. You might create so many polygons that your PC grinds to a halt – a decent amount of RAM and a capable graphics card is definitely recommended. But careful application of its tools and liberal use of the undo shortcut should be all you need to create something very cool indeed.

1 GET STARTED

Your first few steps in Sculpttris really couldn't be much simpler. Find the installer at pixologic.com/sculpttris and download it. You're asked to give up a bit of personal info to get the link, but you don't explicitly have to – the link isn't sent to your email, so lie if you must. Install it, run the software and you hit the interface. Tools at the top left, settings for the current tool running along the top of the window, and a big ball of gray clay slap bang in the middle, ready to be molded by your mouse, with a line of symmetry running down its centre. Give that clay a click right now. The default tool, and one you'll come back to again and again, is 'draw', an additive tool that essentially dollops a little more clay on top of whatever you're working on – the area you clicked, highlighted by the orange circle, should grow a little. Hold down Alt and you invert the draw tool, and scoop away clay instead; this switch between additive and subtractive modes is true of just about every tool in Sculpttris's palette, with a couple exceptions.

2 CAREFUL DOES IT

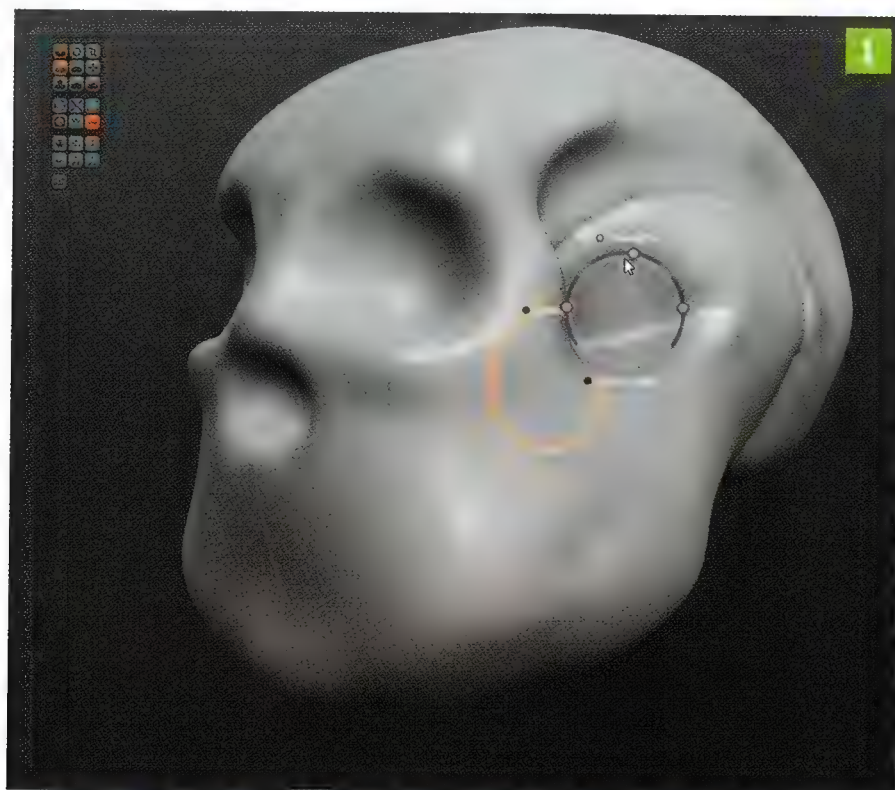
You may have noticed that the draw tool is a little trigger happy at this point. Using it leads to you adding or removing gigantic handfuls of clay, rather than performing the intricate molding you might be expecting. This is actually fine, because a real clay sculpture is generally made by lumping balls of material together, then smoothing them down later on. So use it, sparingly, to rough out the vague shape of the thing you're trying to create. There are only 11 undo levels stored, so be careful; you'll want to use small strokes rather than just holding the left mouse button and scribbling, but give yourself enough breathing room to take back mistakes. You can rotate your model by holding the right mouse button and dragging, pan by doing the same thing with Alt held, or zoom with the mouse wheel.

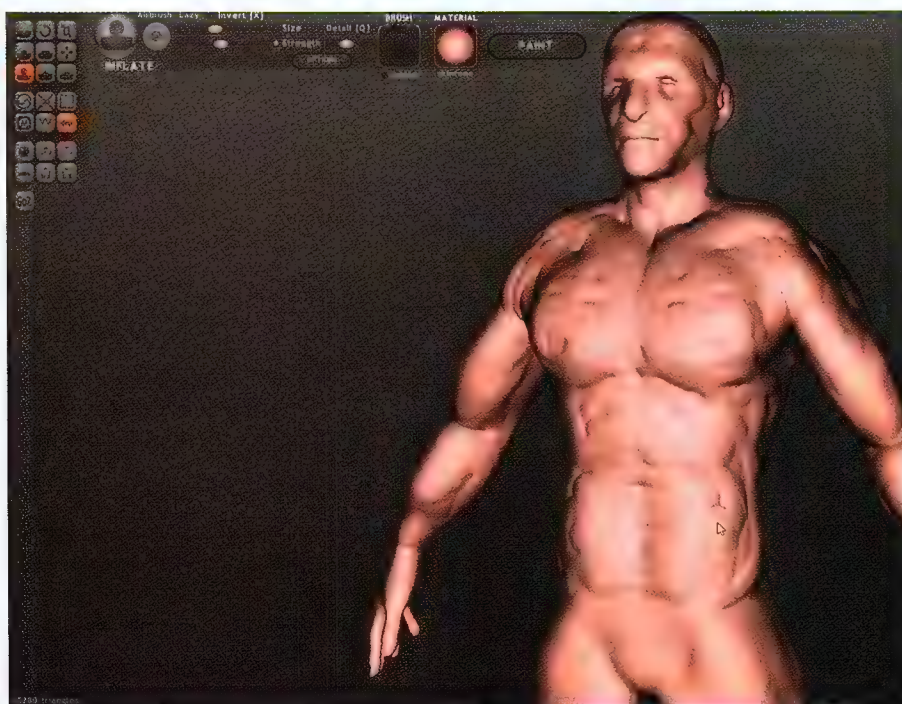
3 TWEAK THE TOOLS

This brings us to a curious feature of Sculpttris' interface. Although zooming brings your model closer in view, your tool remains the same size, meaning that you can now add finer details. This is certainly one way to get intricate, but you need to use the sliders for more pinpoint control. Size, as you might expect, alters the radius of the circle of influence, again maintaining the relative size from your viewpoint, even as you zoom, while strength tweaks the amount that the tool affects your model. We generally recommend using lower-strength values where possible – the gentler you are, the less likely it is that Sculpttris will place a stray vertex somewhere it shouldn't be, and cause you problems down the line. Hit Space to bring a quick slider control up close to your cursor.

4 SMOOTHE IT OUT

You've added lumps, and by now you'll have created a rather rough outline of the object you're trying to create. You can now use two tools to refine your broad shape into something more workable – smoothe and flatten. The former is accessible no matter what tool you have selected. Simply hold Shift to quickly switch to it (or awkwardly select it from the tools panel, though this is a much less





Import and alter

Sculptor outputs in the widely used OBJ file format, and can import OBJ files, too. At least, it can import most of them — it complained at us if the models entirely consisted of four-sided polygons or quads, so bear that in mind. If you don't want to start with a simple blob of clay, you can base your creations on an imported model. Hit the import OBJ button, and pull in something you've downloaded from the likes of free3d.com. If you don't want to increase the complexity of your model while working, set the detail slider to zero, as it is by default — these models are usually constructed to use the bare minimum of polygons, though, so you'll likely want to up the detail if you're making significant changes. If you're only looking to play with Sculptor for a bit of fun, this is a great way to get started.

efficient way of quickly prototyping your mould), then click and drag over your model to even out any rough edges. Again, this benefits from a lower strength, which you can set independently from the strength of your current tool, and it's worth noting that you can't invert the smoothe tool with Alt to make things rougher, because that would be silly. Flatten is a slightly more extreme tool, and one you'll use less often — click a surface, and drag the circle over a higher or lower area to even things out to match the level of the surface on which you began your click.

S CREASING UP

The crease tool, which we've used to add the cracks between the plates in our skull [Image 1] is — despite our over-enthusiastic use of it here — probably best left alone until the end of proceedings for two key reasons. One, it's primarily a detail tool; two,

it doesn't play nice with smoothing. This means it'll be the most prominent cause of vertex errors in your model, and once they're there, they're nigh on impossible to get rid of. If you must use it, pick a low strength and a large size, and crease gradually. The same goes for the pinch tool, which isn't exactly a reverse crease — it behaves slightly differently, pulling your drawn bumps into more prominent ridges, but it's still dangerous.

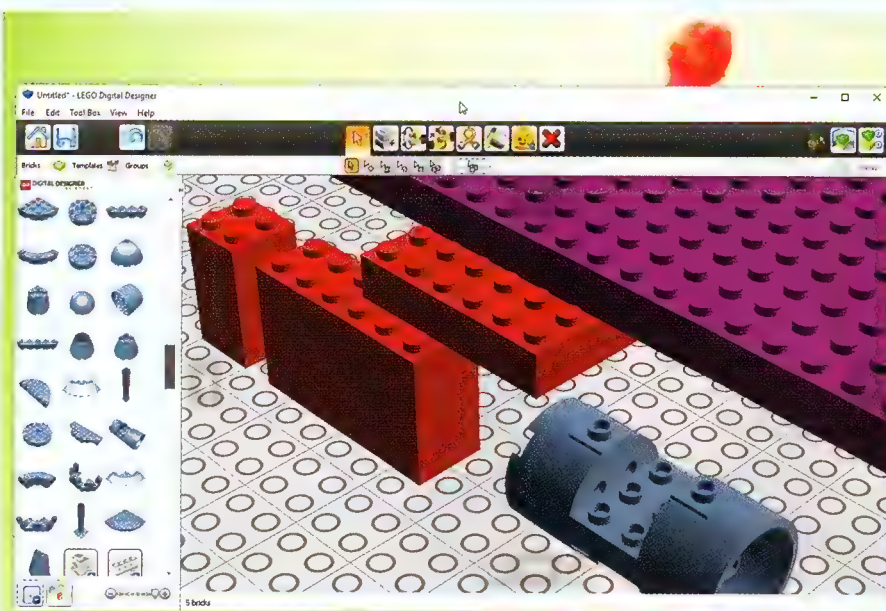
6 MASKING OFF

Sculptor's rather vague, flamboyant circle of influence can be rather frustrating; editing one thing can lead to changes in other areas of your model. For our alien's (rather frightening) teeth, we've avoided this by using a mask, highlighting the area we want to work on, and eliminating others. Before you go masking, though, it's important to know that the mask brush does, by default, actually add

polygons to your sculpture in order to cut off precisely the area you wish to work on. It doesn't change its form at all, but it usually increases the overall complexity of your model. To prevent this, drag its detail slider to zero — now it's restricted by the polygons you have already defined. The same is true for any of the tools we might use.

In our example [Image 2], we've masked the whole head off, and left only the mouth region open for editing. You can do this by selecting the mask brush, holding down Ctrl, and clicking the background to invert the current mask. Because the whole model begins unmasked, the entire thing now becomes masked. Now, hold down Alt while drawing with the mask brush to invert it, essentially unmasking the bits you want to work on. You don't need to go this extreme, though; unless you foresee your cursor flying all over the place, a simple ring around an object you'd like to edit, or a mask over





Other free options

While we do love Sculpttris, its not been updated for a while, and it's still floating around in its alpha form, meaning there are quite a few bugs. Luckily, if you want to play with 3D, you're not limited to pro-level packages, which typically cost upward of \$500. Windows 10's Creators Update, for example, introduces Paint 3D, a simplistic take on modeling, which lets you chuck around primitives and crudely inflated 2D sketches. On the other end of the complexity scale, you could try apps such as venerable open-source subdivision modeler Wings 3D (www.wings3d.com) or even the excellent modeling portion of Blender (www.blender.org). And if you're really only in this to play, the infinite building blocks of LEGO Digital Designer (idd.lego.com) could be just the 3D toybox you need.

a bit you've just got right – such as the eyes [Image 3] – should suffice. When you're done masking, hold down Ctrl, and drag the background to reset the mask to defaults.

7 GRAB & GO

If you want to make interesting effects, the grab tool is for you. It enables you to pull your material, but it's not entirely realistic – you can drag clay from a single point without necessarily distorting your whole model, for a start. So why, if it's so useful, have we waited until now to mention it? Well, grabbing and masks go very well together. Mask off an area, and start pulling the clay around it –

again, being gentle, gradually tweaking using small motions, and moving the camera to give you the perfect angle – and you can create, for example, worryingly ugly lips. Mask off two sides and pull, and you can create fins or other flappy extremities, which can later be grabbed, with the correct combination of tool settings, to be angled or curved. Don't think you have to use masks, though; for our alien's jaw-tentacles [Image 4], we used the grab tool set on high strength, with a fairly narrow size, gradually pulling each longer and longer. It's hard to get too precise with this tool, so it's handy to use it in places, like our deliberately floppy tentacles, where Bob Ross-style



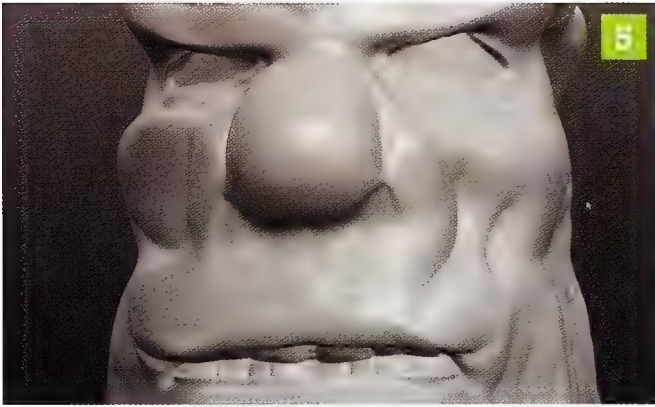
"happy little accidents" enhance the look rather than ruining it.

8 TOUCHING UP

The next step takes as long as, or possibly longer than, the initial moulding phase. It's time to get deep. Zoom in, and start adding details. Use the draw tool, close up, with a narrow focus and medium strength, to add bumps and ridges, quickly smoothing them down to give extra life and dimension to your model. Go wild with the crease tool, adding wrinkles and blemishes. When you're happy that the symmetrical features of your model are complete, hit the symmetry button to edit each side individually – it's a one-way process, so only do this when you're sure you don't need to mirror anything. You can now work on the centre line of your object, which is tricky with symmetry active, and add individual features, such as scars [Image 5]. Bear in mind, if you're creating a face, a bust or an unpleasant alien guy, that no face is actually symmetrical, so use the grab tool with a wide radius and a reasonably low strength to shift elements around. Make one eye very slightly lower than the other, tweak the nose, use this opportunity to add expression to your face. We masked off the eye area to pull the brow down slightly, making our visage slightly more threatening.

9 SIMPLIFY IT

It seems counter-intuitive after all the fine features we've added, but the next step is to remove detail.



As you construct, you'll notice the number in the bottom-left of the Sculptris window go up. This is counting the number of polygons used in your model; the higher it is, the greater the impact it has on your system. Switch on wireframe mode [Image 6], and you'll see the truth within your creation. That rounded, soft clay isn't curvy for nothing. Deep white strips of polygons generally follow areas of heavy creasing (we told you it was dangerous), and you may even find heavy clusters of triangles where there's no reason for a big patch of detail. So leave wireframe mode active, and grab the reduce brush tool. Start gradually reducing the detail in those over-complex areas, and watch the polygon count drop as you do so. Holding the mouse button and scribbling doesn't work with this tool – it's more like the flatten tool, in that you should begin your swipe on an area of lower detail, and drag it over higher-detail areas to bring them back into line.

10 PERFECT PAINTING

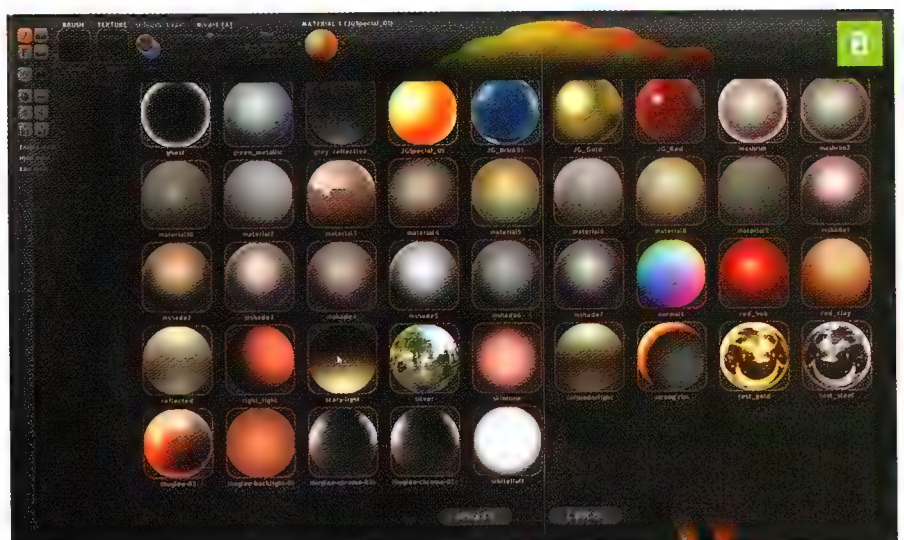
Time for another one-way process: Once you're sure you've completed the sculpting portion of your model, you can transfer into paint mode by clicking the paint button at the top of the interface. It's not entirely one-way – you can jump back to your model later, and add small bumps and features within paint mode, but if you start modeling again, you lose any painting you've done. Sculptris' painting tools are not its finest feature, but they're a good way to make your model more presentable before you share it with the world.

The first thing you need to do is choose a base material for your model [Image 7], by clicking the sphere toward the upper-right of the interface. There are tons to choose from, which give different levels of reflectivity and lighting, so try a few. You can choose to inherit the colour, as well as the light mapping of your material by toggling the option below the sphere. Now comes the painting part. Begin daubing



away with the paint colour tool at a high strength, and you quickly find it's like attempting to apply make-up with a broom – the accuracy isn't there. You can drop the strength and, by clicking the button above the tool settings, switch on airbrushing for a more subtle effect, but it's difficult to create something that doesn't look silly, particularly if your early

sculpting put a few polygons out of place, making colouring them in illogical or impossible. The best use of the paint tool is to bring out the cracks and crevices in your model [Image 8] – paint it one uniform colour, perhaps with the fill tool, then airbrush its valleys with a darker colour, using the cavity button to pick them out specifically. ■



Advanced Kodi tips & tricks

Want to progress beyond your vanilla Kodi knowledge? Nick Peers can show you a thing or two.

When it comes to consuming media on your PC – be it movies, photos, home video or music – there's no substitute for Kodi. It's equally at home providing you with a big-screen-friendly interface for locally stored content as it is streaming media over the internet. You can, with the right help (as in this feature), even use it as a front end for playing classic games from yesteryear.

The basics of Kodi are reasonably straightforward. Point it to your local music, movie and picture folders, and you're good to go. That said, the user interface does come with a bit of a learning curve attached, and some of its best features are buried away behind seemingly impenetrable dialogs and settings. This, however, is where we come in.

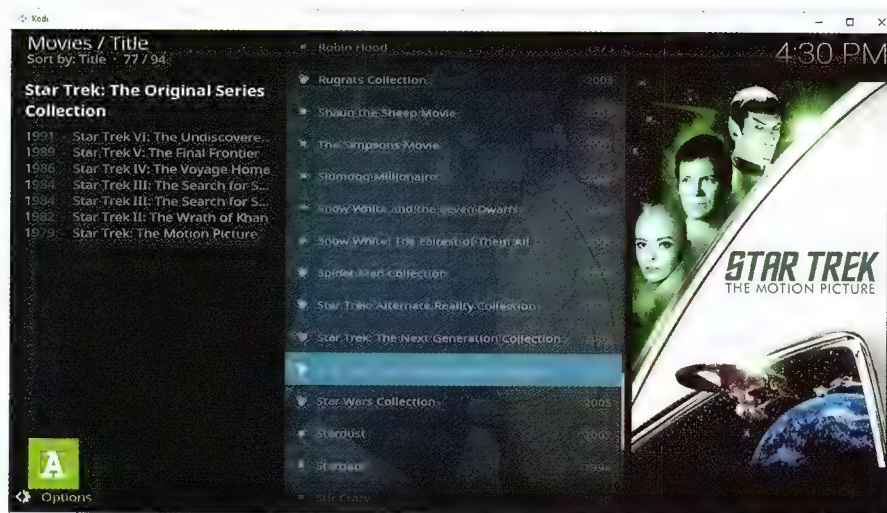
We're going to skip the basics – adding a media folder to your library isn't rocket science, thankfully – and dig deep beneath Kodi's surface to reveal some of its best kept secrets. Everything from changing library view to auto-starting add-ons, and using Kodi as an Airplay audio receiver is covered here. Oh, and we'll show you how to name and organise your media library so Kodi's scrapers can download all that gorgeous artwork and extra info, too.

1 EXPAND YOUR LIBRARIES

The quickest way to manage your library – and add new content (including music) – is to open Settings, and browse to 'Media Settings'. From the Library section, click your chosen library – videos, music or pictures – under Sources, and click the Add option to add another folder to your library. Remember to name your media correctly – head over to www.filebot.net, to grab a handy tool to help you with this.

» While you're in the Library section, you can periodically clean your video or music libraries to remove files that have been renamed, deleted or stored on a drive no longer connected to your PC, but to do this, you must first click the 'Standard' setting at the bottom of the screen in order to switch to 'Advanced', and reveal the cleaning options.

» If you'd like to streamline your movie library, navigate to the Videos section, and flick the 'Show movie sets' button to on. Now all the movies in a specific series (such as *Star Trek*,



Star Trek II, and so on) are grouped together [Image A] – click the main entry to drill down to browse and play each individual movie.

2 TWEAK MUSIC INFO

Got an obscure album the default music scraper can't identify? Go to 'Media Settings > Music' and click the 'Default provider' option for album or artist information, then click 'Get more...' to pick from a range of alternatives. And if your music has been tagged, but you'd prefer to use the information provided by your music scraper, make sure you switch to Advanced view, and flick the 'Prefer online information' switch to on.

3 CONFIGURE LIVE TV

If you've set up live TV on your PC (or indeed any PC on your network) using TVheadend or a similar service, select TV from the main Kodi menu, and choose 'Enter add-on browser'. Locate and select your chosen PVR server, then click Configure to set up access (for example, to connect to a remote PVR server, enter its IP address and PIN access code). Click Enable and press Esc to go back to the main screen.

» You'll see several widgets under 'TV', making it easy for you to access the TV guide and previous recordings, as well as browse live TV (and radio) by clicking the remote, and choosing which channel to watch. If you've previously found Kodi unwieldy with live TV, now's a great time to try it again – you'll find the latest update has made it easier and more responsive, even when streaming over your network.

4 CONFIGURE GAMEPAD

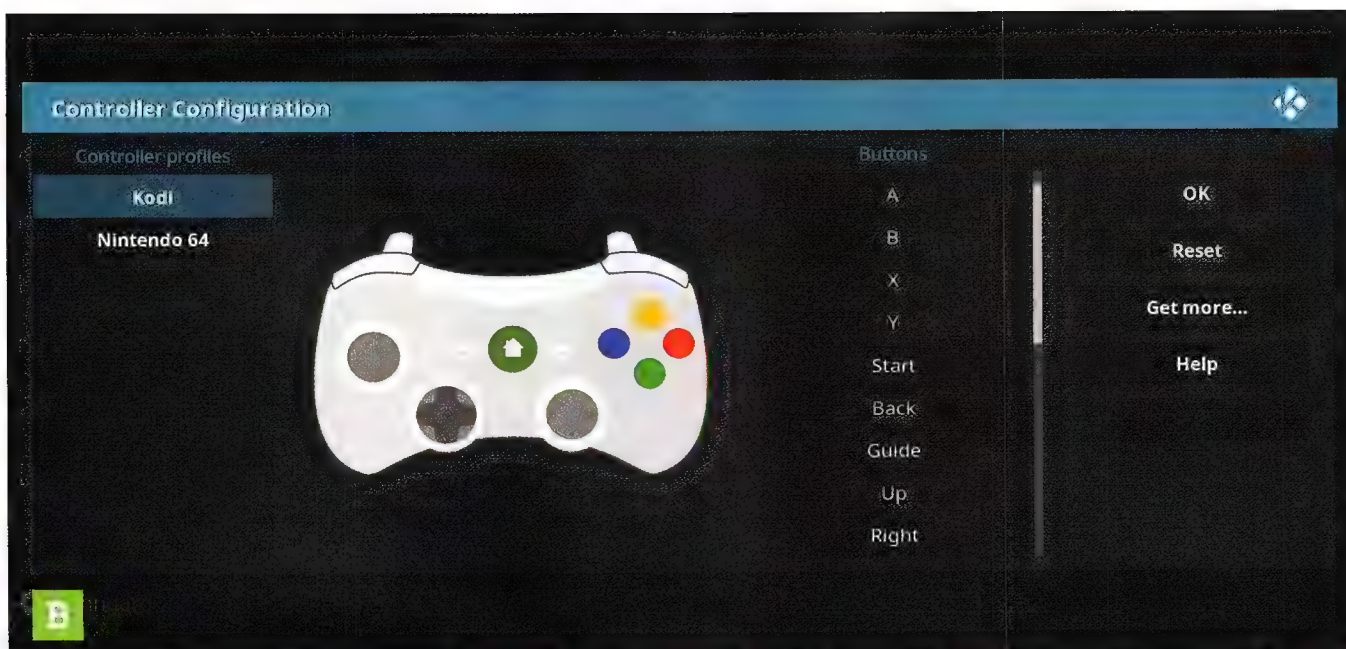
If you're using Kodi on your gaming rig, why not use your gamepad to navigate? To set things up, simply press a button on your gamepad while Kodi is running, and it should ask if you want to configure it [Image B] (or you can go to 'Settings > System Settings > Input > Configure attached controllers', if you prefer).

» You'll see a default configuration – Kodi – is present. You can manually link the controls on your gamepad by clicking the buttons on the right, and following the instructions, at which point, your controller should work. While you're here, why not flick the 'Enable rumble for notifications' switch to on?

5 CONFIGURE KEYBOARD SHORTCUTS

It's worth familiarising yourself with Kodi's keyboard shortcuts. There are the playback controls, for example: P to play, X to stop, left/right arrow keys to skip back or forward 30 seconds, or R/F to rewind and fast forward – press once for 2x, then keep pressing to speed up. Or press the backslash (\) key to move between windowed and full-screen mode.

» All well and good, but what if you don't like the keyboard shortcuts Kodi has picked, or you'd like to configure some more of your own? From the home screen, select 'Add-ons' and click 'Enter add-on browser'. Click '...' if necessary to return to the main screen, then choose 'Program add-ons' and scroll down to locate and install the Keymap Editor. Once done, click Run and choose Edit



to review current shortcuts and define your own, using both your keyboard and your game controller buttons.

6 ADD A REMOTE

If you've set up Kodi in your living room, you don't want to have to use a keyboard or mouse to control it. If the game controller option doesn't appeal, simply turn your cell phone (Android or iOS) into a fully functional remote. First, you need to configure Kodi: Navigate to 'Settings > Service settings > Control' and enable 'Allow remote control via HTTP'. Enter a username and password for security reasons — you'll need this later to set up the connection with your cell phone. Also, flick the 'Allow remote control from applications on other systems' switch to on, and if you've not already done so, switch on 'Announce services to other systems' under General.

» Next, install either Kore (Android) or Official Kodi Remote (iOS) from the appropriate app store. iOS users can open it, tap 'Add Host', followed by 'Find Kodi'. Enter your username and password, then tap Save to hopefully make contact and take control.

7 A CHANGE OF SKIN

Kodi 17 defaults to the Estuary skin, a big-screen-friendly skin that still lacks a little oomph. If you're running Kodi on a touchscreen device, we recommend going to 'Settings > Interface Settings' and clicking Skin [Image C] to switch to Estouchy instead — it's a similar skin to Estuary, but optimised for touchscreen devices (short tap to select, long tap to bring up the context menu for an item).

» Alternatively, click 'Get more...' to choose from over 20 more. Pining for the look of previous versions, for example? Confluence is still an option

(or try Aeon Flux for a more updated approach). Visit kodi.tv/addons/look-and-feel/skins for a better view of how each skin looks without having to install it.

8 FURTHER CUSTOMISATIONS

Once you've installed your new skin, you can tweak it further from the same

Skin menu — change its theme to try a different colour scheme, for example, or tweak the fonts to your personal choice. Select 'Configure Skin' and you skip to the 'Settings > Skin' menu, where more granular changes can be made, such as picking a different background image or pattern, selecting which libraries and other items (such as live TV) to show on

Make your own set-top box

There are plenty of options for getting Kodi to the living-room TV, including a dedicated PC, Raspberry Pi or even an old Android device.

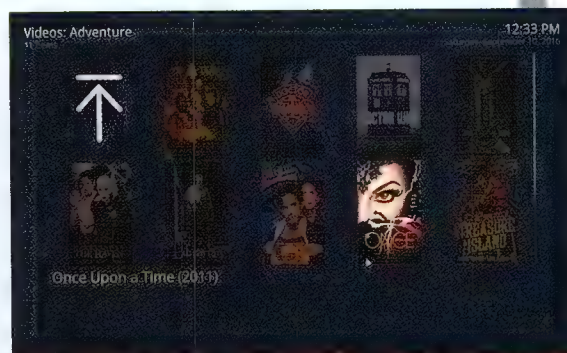
Kodi runs on Windows, Mac, and Linux, but you can also install it on your Android tablet (or jailbroken iPad), plus downloaded dedicated distros for turning a low-powered computer, such as a net-top PC or Raspberry Pi, into a dedicated Kodi set-top box.

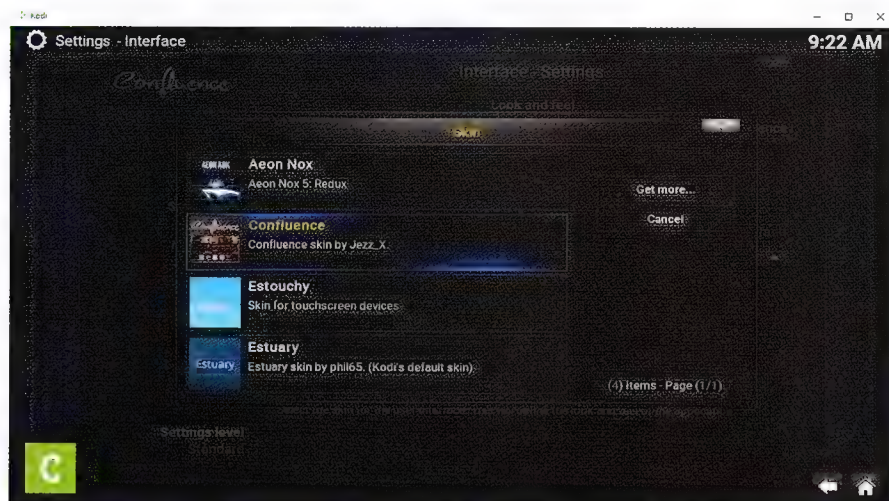
Kodi recently dropped all support for its dedicated Kodibuntu distro, which paired Kodi with Ubuntu 14.04. Existing Kodibuntu/XBMCbuntu users should be able to update to Kodi 17.1 through the Terminal, though:

```
# sudo apt-get update && sudo apt-get-dist-upgrade
```

If you're new to running a dedicated Kodi machine, then you're left with two choices. Raspberry Pi users are best served by OSMC (osmc.tv), which can also be installed on a jailbroken first-generation Apple TV. You can find links for downloading a tool to create the required microSD card on Windows, OS X and Linux, or you can download disk images directly.

OpenElec (openelec.tv) provides dedicated builds for AMD/Intel-powered PCs (including lower-powered Atom and Fusion CPUs), plus the Raspberry Pi, and a selection of WeTek third-party devices, as well as Freescale iMX6 devices from the likes of Cubox.





the main screen, or choosing how much detail about each media item is displayed. Options vary from skin to skin – and don't always appear in the same place, so be prepared to dig deep to find them.

9 POWER-SAVING SETTINGS

If you've hooked up Kodi to your living-room TV – perhaps through a dedicated computer (see boxout section on previous page) – you should take measures to configure power-saving to both protect your TV and reduce energy consumption. To do this, go to 'Settings > Power saving' and click the up arrow next to 'Put display to sleep when idle', to set a delay of five minutes – you can increase this all the way to 120 minutes, if you'd prefer, but a 5 or 10-minute delay is usually best.

» If you'd like to power off Kodi after a set period, switch to Advanced or

Expert view, then set 'Shutdown function' to one of 'Shutdown', 'Hibernate' or 'Suspend', before setting the 'Shutdown function timer' to a delay – again between 5 and 120 minutes – based on inactivity.

10 MAKE KODI AN AIRPLAY RECEIVER

The following feature can be troublesome to set up – and frequently breaks between updates – but if you would like to stream audio from your iPhone or iPad to your PC or TV's speakers, give it a go. First, if you don't have iTunes installed on your PC, install Apple Bonjour from support.apple.com/kb/dl999, then go into Kodi, and navigate to 'Settings > Service Settings > General' to enable Zeroconf, and review your 'Device name', which is how Kodi will advertise itself on your iOS device when detected.

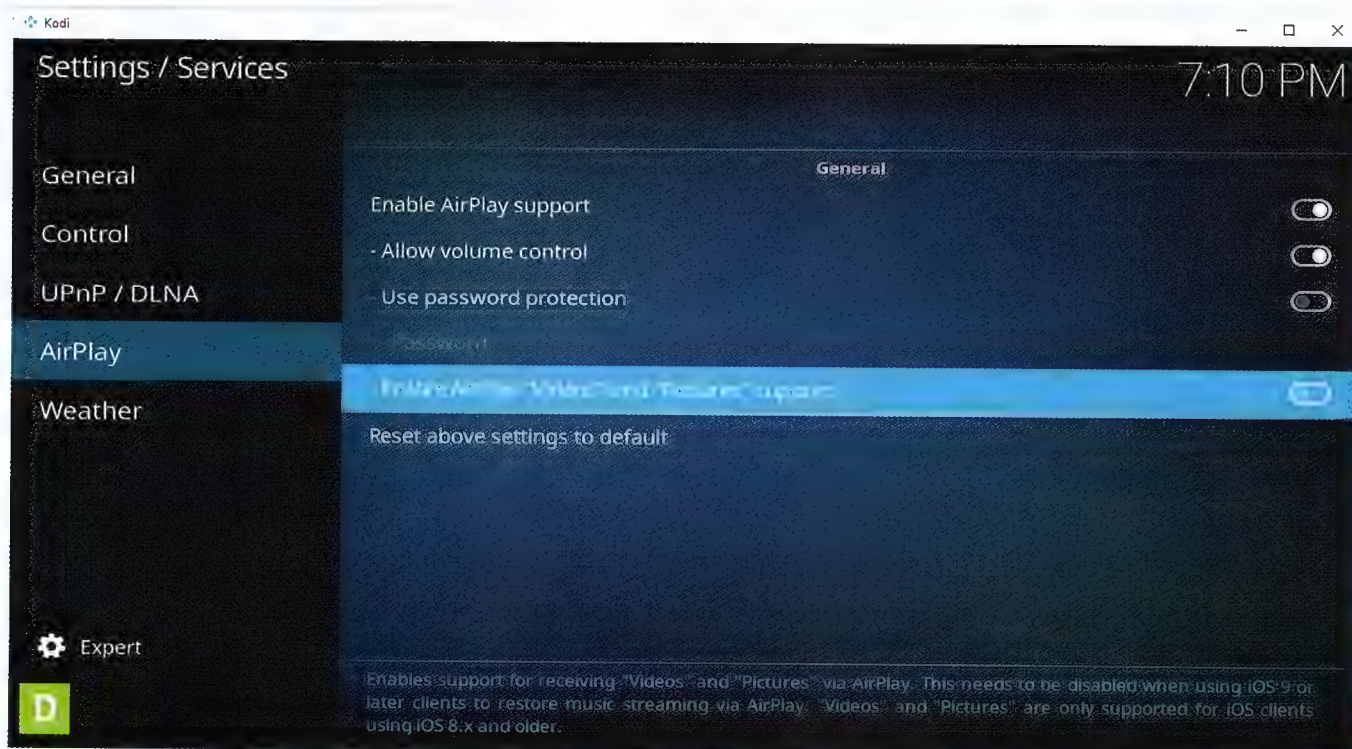
» Now select AirPlay and flick the 'Enable AirPlay support' switch to on. Switch to Expert and you'll see a new option appear: Enable AirPlay 'Videos' and 'Pictures' support (Image D). This needs to be switched off for AirPlay to work with devices running iOS 9.0 or later. Once done, you should find Kodi appear in the list of AirPlay devices on your iOS devices.

11 ADD ADD-ON REPOSITORIES

Some of the best Kodi add-ons aren't bundled with the official repositories (repos) – to get those, you need to install additional repos. This is slightly fiddly, but once you know how, it's reasonably straightforward. For the following example, we're going to add the Fusion repo.

» First, go to 'Settings > System > Add-ons'. Flick the 'Unknown sources' switch to on, and make a note of the warning. Next, go to 'Settings > File Manager'. Double-click 'Add Source' on the left, then click 'None' to bring up the virtual keyboard (which you can ignore). Type the following web address, and click OK: <http://fusion.tvaddons.ag>

» Name the source "Fusion" and click OK. Next, return to the home screen and click 'Add-ons'. Click the box icon in the top-left, and choose 'Install from zip file'. Scroll down, and select 'Fusion' from the list, then browse to "kodi repos/english," where you'll see a host of available repos to choose from. Select a zip file, and click OK to add that repo to your list. Now, when you open 'Add-ons > Download', you'll find additional add-on choices in each category.



12 REMOVE REPOS

Third-party repos are by their nature risky, and can contain dangerous material (see kodi.wiki/view/Banned_add-on for a list of so-called "banned" repos – Fusion is one of these). If you decide a repo isn't for you, remove it. Go to 'Add-ons > My add-ons > Add-on repository'. Click the unwanted repo to bring up its window (you can configure its update settings from here, too – for example, switch between auto and manual updates). To remove it completely, click Uninstall, then close and restart Kodi.

13 AUTOSTART ADD-ONS

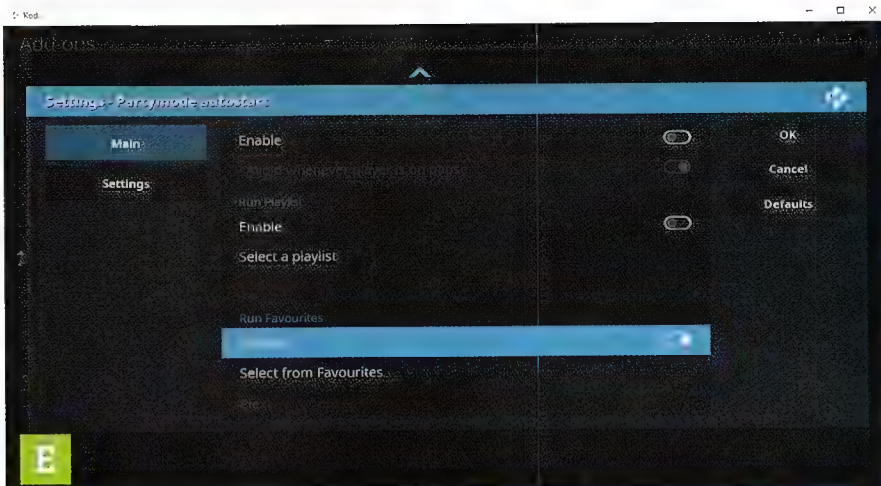
Here's the scenario: we've got a Raspberry Pi set up to exclusively run the Plex add-on in Kodi. We want to autostart Plex with Kodi to save the hassle of manually accessing it from the main menu. You can autostart add-ons using a script, but a simpler way is to use the Partymode Autostart add-on [Image E].

>> Add your add-on to the Favorites menu: Browse to 'Add-ons', then locate your add-on (Plex in our example). Right-click it and choose 'Add to Favorites'. Go back to the main Add-ons screen and choose 'Downloads > Services', where you'll find 'Partymode Autostart'. Once installed, right-click it, and choose 'Settings'.

>> Under 'Main', enable it to 'Run on Startup' and reduce the delay to 0 seconds. Make sure 'Run on Screensaver' and 'Run on Playlist' are disabled, then scroll down and enable 'Run on Favorites', before clicking 'Select from Favorites' to choose your add-on. Click OK, exit and restart Kodi. The normal menu should briefly appear, but then your add-on should kick in. Job done!

14 MULTIPLE PROFILES

This tip will appeal more to those who use Kodi on a shared device, such as a Pi connected to your TV. Go to 'Settings > Profile Settings > Profiles'



[Image F]. Click 'Add profile'. Type a name and click OK. Leave the profile directory as it is (click OK again), then choose whether this profile shares the same media library as the default user (choose the read-only option to stop people from modifying the library), as well as its media sources, then click OK. You can then opt to copy settings across from the default user or let them start from scratch.

15 LOCK DOWN PROFILES

You may not want your users to be able to tweak settings, in which case, select the profile lock option, and – if necessary – set a profile lock password when prompted: either a numeric PIN, a full-text password or even a gamepad button combo. Make your choice, then choose what parts of Kodi to lock (effectively disabling them), from libraries (music, videos, pictures, programs & scripts) to the file manager, settings and add-on manager. When locking settings, you can allow users to access some settings by choosing a level (standard, advanced, or expert).



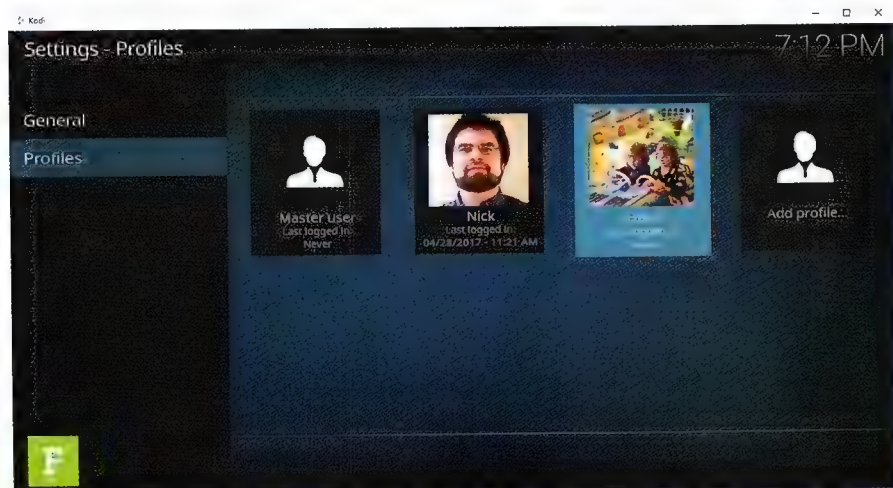
Play games through Kodi

The Rom Collector Browser add-on enables you to transform Kodi into a hub for playing games, as well as accessing your media.

It supports standalone games, as well as emulator ROMs – these need to have been configured already (for example, through a GUI-friendly MAME variant, such as MAMEUI: www.mameui.info).

Assuming these are all in place, go to 'Settings > File Manager' and choose 'Add Source' to create a source pointing toward your game emulator folder (or parent folder, if multiple emulators are installed). Now install the Rom Collector Browser add-on via 'Add-ons > Download > Program add-ons'. Once installed, launch it and choose Yes to create a config file. Choose the online option, followed by your platform, before pointing the add-on to the emulator program folder containing your ROMs and artwork folder in turn. Once done, you can include additional ROM emulators if required, before reviewing the import settings and clicking 'Import Games'.

The scrapers aren't always accurate, so you may want to reconfigure Rom Collector Browser: Press the C key to bring up a menu, then select 'Edit Rom Collection' to make changes.





Build a Ryzen workhorse

Just because AMD's new chips offer great value for money, that doesn't mean we have to scrimp and save, says Alan Dexter.

THE CONCEPT

We're always comparing hardware here at APC. Every review, build and feature sees us comparing components (or whole systems) against what has gone before; either explicitly when picking components, or more subtly when alluding to performance metrics.

Intel has basically dominated the market when it comes to DIY workstations for the last five years (or more) with the X99 platform and its eight-core Core i7 or up to 16-core

Xeons have been the go-to parts if you want to build a machine for 3D rendering, super-resolution video work and today's other supremely demanding computing tasks.

The arrival of AMD's Ryzen chips has changed all that, and while there's still some work to be done when it comes to making these CPUs appealing for mainstream rigs targeting 1080p gaming, when it comes to work tasks, the red team is very definitively back on the table.

So this month, we've chosen to focus on Ryzen's key area of strength – constructing a machine that's made to handle workstation loads. As such, the component choice sometimes isn't the standard desktop fare we're used to in PC Builder – the Radeon Pro WX 7100 that can be found inside this machine is aimed at serious CAD work, for instance, not playing the latest games at 4K. With that said, it's time to get building...

STARTING ON THE RIGHT FOOT

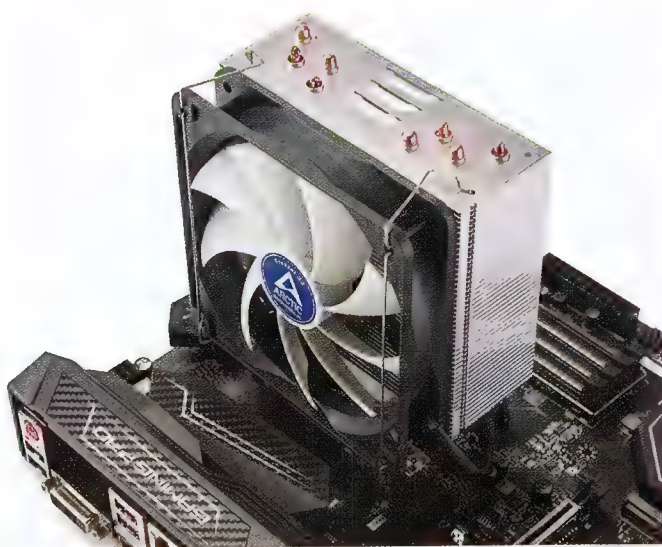
Obviously, the starting point for this build was the Ryzen 7 1800X, the high-end of AMD's current Ryzen lineup. We did briefly toy with the idea of trying to build a machine on a much tighter budget, to see what sort of value for money we could squeeze out of AMD's new architecture, but we ultimately decided that could wait until more low-end Ryzen CPUs have landed. If you're building a Ryzen rig right now, it's more than likely to be for high-end work-oriented tasks, and in that sense, rendering-time is money after all. Once we'd decided on the chip to use and the general ethos of building something that needs to at least give Intel's finest a run for its money, a lot of the other components came together quite easily.

On the motherboard front, we went for the MSI X370 Gaming Pro Carbon. Into that, we slid four 8GB sticks of Corsair's sleek Dominator Platinum RAM, alongside a serious graphics card in the form of the AMD Radeon Pro WX 7100. There are plenty of all-in-one solutions for keeping a Ryzen cool, but here we wanted to go with an air cooler, and so reached out to Arctic, who provided us with a Freezer 33 for our build. We've used our standard combo of an M.2 SSD and 7,200rpm HDD for storage, which give us a good base for a fast boot drive, coupled with plenty of space for data at the same time. We eased all of this gorgeous gear into the spacious Corsair Carbide Air 740 case, and powered it all with the frankly over-the-top HX1200i Platinum from Corsair as well.

PARTS LIST

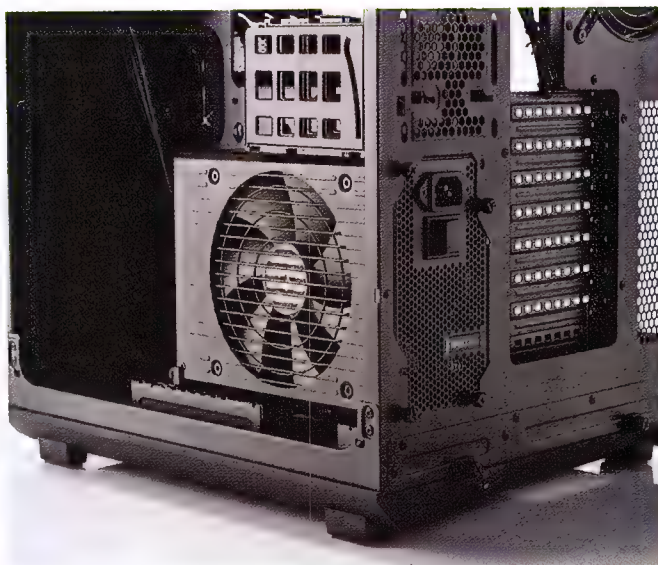
PART		STREET PRICE
CASE	CORSAIR CARBIDE AIR 740	\$219
MOTHERBOARD	MSI X370 GAMING PRO CARBON	\$279
CPU	AMD RYZEN 7 1800X	\$679
MEMORY	32GB (4X 8GB) CORSAIR DOMINATOR PLATINUM 2666	\$479
GPU	AMD RADEON PRO WX 7100	\$1,099
PSU	CORSAIR HX1200i PLATINUM	\$399
STORAGE 1	SAMSUNG 960 PRO 512GB PCIE NVME SSD	\$449
STORAGE 2	WESTERN DIGITAL BLACK 2TB 7,200RPM HDD	\$179
COOLING	ARCTIC FREEZER 33	\$69
OS	WINDOWS 10 HOME 64-BIT OEM	\$179
TOTAL		\$4,030

"We've chosen to focus on Ryzen's key area of strength — constructing a machine that's made to handle workstation loads."



1 INSIDE OUT

There are two schools of thought when it comes to building PCs: check the core components outside of the case first, and the more optimistic route of throwing it all together in the chassis, and only finding out if you've got problems once you flick the switch. For this build, we were of the more pessimistic persuasion, partly because our chip had some bent pins that needed straightening. It also means you have lots of room when piecing together the cooler. The Arctic Freezer 33 was fairly straightforward, as it uses the backplate that comes with the mobo. Even so, we ran into a few problems while screwing in the heatsink, which resulted in a screw sheering. We had a spare backplate, but if you're not so lucky, don't force it. Like we did.



2 ROOM FOR POWER

We love compartmentalised cases, because they promote good airflow and clean builds, and the Carbide Air 740 gives you plenty of space in both sections for your components. The rear area is for the power supply and your hard drives, with removable drive cages for 3.5-inch and 2.5-inch drives. There is ample space for the slightly oversized power supply we used in this build, and the fact that it is completely modular made for a particularly easy installation. A thumbscrew helps position the PSU in place with a tiny retaining bracket, as you get it lined up with the rear grille, which is a neat addition.



3 CAPACIOUS INTERIORS

Sliding the motherboard into place was every bit as easy as installing the power supply. In fact, because the PSU is in its own compartment, it frees up plenty of space around the motherboard, making this one of the easiest installs we've ever done. After clipping the rear IO shield into place, the board slotted in neatly. One thing to note here is that we had to spin the rear case fan around, so that it was working in tandem with the Arctic Freezer 33, as opposed to fighting against it. We could have avoided this by installing the cooler fan the other way around, but we didn't want to obstruct the RAM slots, despite there being plenty of clearance.



5 CABLE GUY

The next step was to spin the case around so we could work on the cabling after installing the hard drive. The Carbide Air 740 uses a tool-free design for holding your hard drives, which means that popping the data drive into the system was really easy — clip the drive into the caddy, then slide it into the cage. There's only room for three 3.5-inch drives in this cage, although there's space for four 2.5-inch drives as well. Cabling was also straightforward, thanks to the copious number of rubber-edged cutouts on the motherboard tray.



4 SMALL SCREWS

Once the motherboard was in place, it was a straightforward task of installing the memory and the M.2 drive. The only awkward bit here was getting the heat spreader — that MSI includes to keep those M.2 temperatures in check — screwed into place. This uses a very small screw, which escaped our grasp a few times when trying to anchor it in place. In hindsight, we should have installed the M.2 drive before placing the motherboard in the case. It's also worth noting that we're using the top M.2 slot, as there are two slots on this motherboard.



6 SINGLE SLOTTER

The Radeon Pro WX 7100 is something of an oddity in these days of over-sized coolers, because it's just a single-slot card. There's an air of no-thrills seriousness about its design, and it's refreshing to not have to worry about making room for a two- or three-slot behemoth. The card only requires a single six-pin power connector, too, which was easy to route around the back of the motherboard. We connected the rest of the cabling at this point as well, pulling it as tight as possible around the back to keep airflow clear on the business side of things — particularly important when using an air cooler on the CPU.



1 Having the hard drives and power supply in the back compartment makes for a clean build, with plenty of room around the motherboard for good airflow, while providing easy access to the various ports. All the cutouts make for some neat cabling options, too.

2 The Arctic Freezer 33 was straightforward to install, and kept the Ryzen 7 1800X at comfortable temperatures in use. You may get a little more overclocking headroom with an all-in-one water cooler, but the simplicity of this solution is a good counter to that.

3 A professional card, such as the AMD Radeon Pro WX 7100, isn't essential for many builds, and if you fancy spending your spare time gaming, an enthusiast-level card may well be a better option. For instance, an RX 580 is half the price, and outperforms it when it comes to gaming.

The everyman workhorse

The big selling point of Ryzen is the multi-threaded performance at a great price. This machine promotes that ethos in a succinct way without compromising in order to get its point across — you could definitely build a cheaper workstation with the same core, but it wouldn't be as rounded a machine. This is a PC that has an eye on its price tag, while knocking out solid performance at the same time.

The build itself was surprisingly straightforward, with the Corsair Carbide Air 740 making for a great basis for a clean build. After constructing so many ITX systems, it's refreshing to have so much room around the motherboard. If you're going to augment your own workstation with plenty of SSDs and hard drives, this comes

heartily recommended — although if you want to install lots of 3.5-inch hard drives, you're going to need to come up with your own mounting system, because the included cage only holds three drives.

The other component that impressed us was the Arctic Freezer 33. Even allowing for the fact we overtightened one of the mounting screws, and needed to grab another backplate, we'd still class it as an easy install. (Besides, that was our fault, not Arctic's.) The Arctic Freezer 7 Pro was an incredibly popular option back when the Core i7-920 was king, and while it's doubtful that the Freezer 33 will regain the throne in these days of all-in-one coolers, it's worth considering for your own builds.

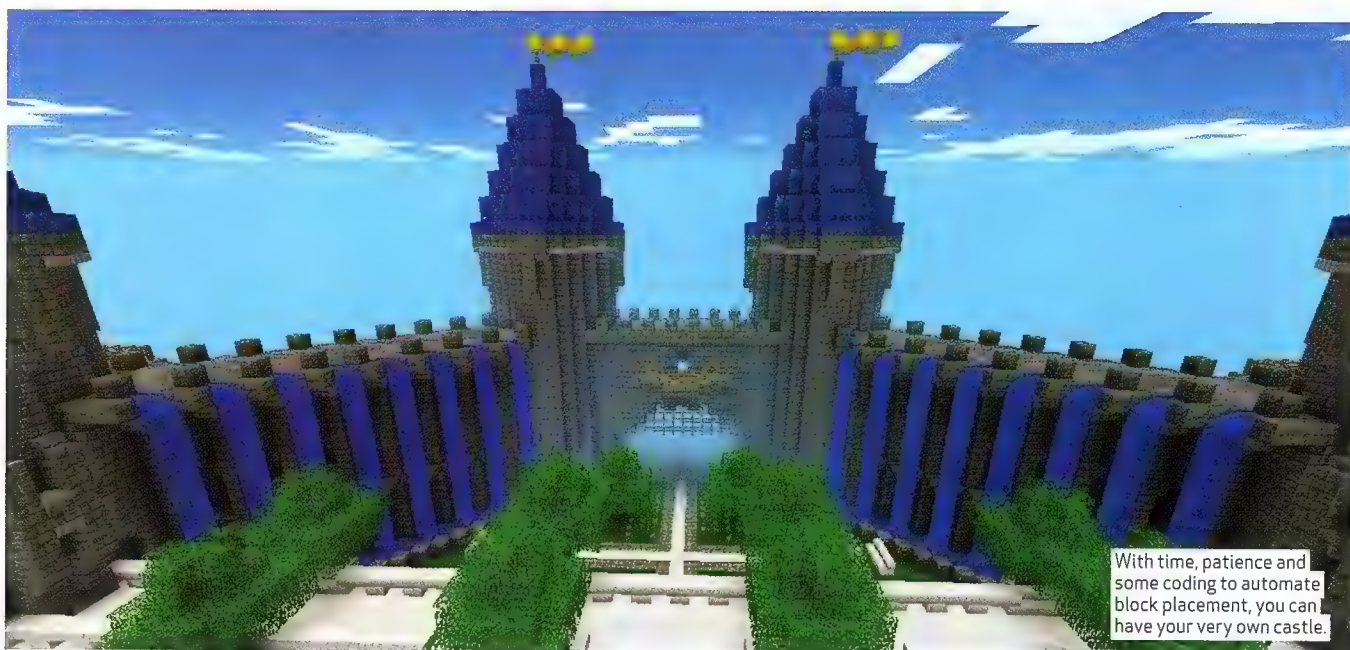
When it came to testing, we could have left the Ryzen 7 1800X running at stock speeds, but that would have felt like we were wasting the chip's true potential. We couldn't get this chip running at 4GHz stably (it would boot fine, but then fall over during a hearty benchmarking session), so settled for a solid 3.9GHz instead. There is an argument to be had for not overclocking at all when dealing with a workstation, but it's in our DNA to push CPUs as hard as possible, and we weren't about to change that stance. Even so, for reference, we did initially run the chip at stock settings, and saw Cinebench R15 post scores of 149 in single-threaded loads, and 1,600 with the multi-threaded test.

It's worth bearing in mind that this is our standard benchmarking suite, and leans more toward gaming than the hardware in this machine is happy with. The Radeon Pro WX 7100 is essentially an RX 480 with slightly slower clocks, which equates to a rather sound thrashing from our test machine (which employs a Fury X for the gaming heavy lifting). You can hit smooth frame rates in most games with some tweaking, but if you're serious about relaxing with your workstation, you would be better off going with either a more powerful card, or conversely a cheaper one. ■

BENCHMARK RESULTS

APC LABS TEST PC		
CINEBENCH R15 MULTI-THREAD	987	1,710 (73%)
CINEBENCH R15 SINGLE-THREAD	196	158 (-19%)
CRYSTALDISK QD32 SEQUENTIAL READ (MB/S)	1,895	3,509 (85%)
CRYSTALDISK QD32 SEQUENTIAL WRITE (MB/S)	949	2,093 (121%)
RISE OF THE TOMB RAIDER (FPS)	76	32 (-58%)
FAR CRY PRIMAL (FPS)	72	56 (-22%)
ATTILA: TOTAL WAR (FPS)	42	28 (-33%)
THE DIVISION (FPS)	73	56 (-23%)

Our Labs test PC uses a Core i7-6700K CPU @ 4.6GHz, an AMD R9 Fury X, and 32GB of RAM. All games are tested at 1080p on max settings, with HD texture packages installed.



Create a Pi-powered Minecraft server

Jonni Bidwell invites you into the amazing and creative world of *Minecraft*. Then reveals how you can host your own server to keep out the riff raff.

Besides empowering a new generation of makers, the Raspberry Pi has also established its merits as a gaming platform. Projects like RetroPie, combined with the Pi's cheapness, mean that it's great for playing old classics. And even some new ones. Like *Minecraft*.

In case you've been living under a rock since 2011, *Minecraft* is the best-selling computer game of all time. It's an open-world sandbox affair in which our hero, Steve, roams around a landscape made of voxels (blocks). Resources can be mined and crafted into other resources, so that Steve can build houses, farm crops, cook food and fight enemies (all rendered in low-res splendour).

A special version, *Minecraft: Pi Edition*, was released in 2013 and has been bundled with Raspbian since 2014. This version is in some ways cut down, in the sense that there isn't any crafting or baddies, and nor is there any limit on the resources available for building. But it does have some features that aren't present in the full game, most notably a Python API for manipulating the world while a game is being played. Not having to worry about creatures trying to kill you or

where your next meal is coming from makes it great for younger players, emphasising the creative aspects of the game. The Python API makes it an ideal platform for aspiring coders, young and old.

To get started, first head over to the Menu, then go to 'Games > Minecraft Pi'. Choose 'Single Player' and then 'New Game'. You'll see that the game window is slightly offset from the application window behind it. Make sure your mouse arrow is parallel with the top of the app window, and hold down to reposition it.

Click 'Start Game', followed by 'Create New'. Your new world will load. Feel free to explore and build. The controls for the game are pretty simple, and are as follows:

KEY	ACTION
W	FORWARD
A	LEFT
S	BACKWARD
D	RIGHT
E	INVENTORY
SPACE	JUMP
DOUBLE-SPACE	FLY/FALL
ESC	PAUSE/GAME MENU
TAB	RELEASE MOUSE CURSOR

You can use the mouse to look around you, too. It can also be used to select items from the inventory. By default, you're holding a sword. Click blocks to destroy them. The sword can also be used to dig. If you select a block from your inventory, you can begin building. Use the right mouse button to place down the block, or the left to destroy it.

CODING BLOCKS

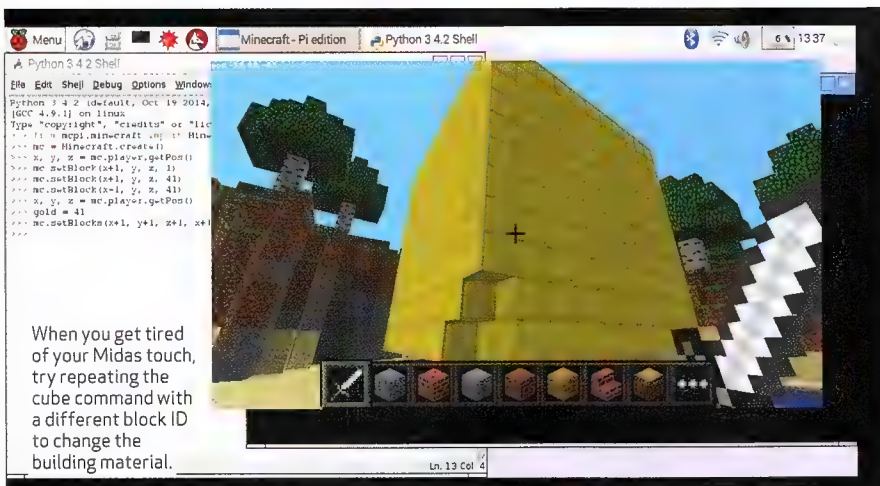
To start coding in *Minecraft: Pi Edition*, press the Tab key while it's running. Go to 'Menu > Programming'. Click 'Python 3'. Try to place the text boxes so they're next to one another.

You can type commands here to change the in-game world. Over time, you can also write scripts to automate tasks for you – for example, a script that places a stone block wherever you walk. So without further ado, let's reprogram the game to display a simple message.

Type in the following commands, pressing Return after each one:

```
from mcpi.minecraft import
Minecraft
mc = Minecraft.create()
mc.postToChat("Hello world,
I'm playing Minecraft Pi!!!")
```

Press Return to display your first in-game message. Next, look at the



top-left of the *Minecraft Pi* screen. You should see your X, Y and Z coordinates. This is an excellent way to work out your location, as well as place blocks precisely.

You can use Python to summon any number of blocks of various materials. First, let's try placing a single gold block immediately behind you.

Type in the following command:

```
x, y, z = mc.player.getPos()
```

You'll need to run the above command each time you move, to give the game your updated coordinates. Press Return, then type:

```
mc.setBlock(x+1, y, z, 41)
```

The number 41 at the end of the last command represents the ID number for gold. Each block or item in the game has a unique ID. If you know the ID of a particular type of block, assign it a name to make it easier to remember.

For example:

```
gold=41
```

Press Return, then run these commands to create a giant 10 x 10 x 10 cube of solid gold:

```
x, y, z = mc.player.getPos()
mc.setBlocks(x+1, y+1, z+1,
x+11, y+11, z+11, gold)
```

This is just a small selection of commands that can be run on *Minecraft Pi*. It's also possible to form complex shapes, teleport the player and even drop blocks as you move around. For a full list of commands that you can run in *Minecraft Pi*, as well as the ID numbers for each type of block, head to www.stuffaboutcode.com/p/minecraft-api-reference.html.

AVOIDING THE MINEFIELDS

As we've discussed, *Minecraft Pi* is very similar to the *Pocket* edition of *Minecraft*, which can be played on handheld devices such as Android phones and iPhones. It can't interact with people using the official *Minecraft* client. According to reports on the Mojang website, it appears the client hasn't been updated in a while, but if you simply want to make simple

Install the full Minecraft game on the Pi 3

Open Terminal on your Raspberry Pi and begin by installing some tools:

```
sudo apt-get -y install xcompmgr libgl1-
mesa-dri && sudo apt-get -y install libalut0
libalut-dev && sudo apt-get -y install mesa-
utils
```

Next, we'll need to enable an experimental graphics driver. Run `sudo raspi-config` and scroll down to 'Advanced Options'. Press Return. Then choose the 'AB - GL Driver' option and enable it.

Now download the official *Minecraft* client with the following:

```
mkdir ~/Minecraft; mkdir ~/Minecraft/
Natives;
cd ~/Minecraft && wget https://s3.
amazonaws.com/Minecraft.Download/launcher/
Minecraft.jar
```

Launch it by running:

```
# java -jar Minecraft.jar
```

Now you need to log in with your username and password. Next, click the Profile Editor tab, then click the box that's underneath Version to open up a new window. Find the drop-down menu named 'Use Version' and choose '1.8.9'. Next click 'Save Profile'.

Click the Play button at the bottom to begin downloading the files. When the downloads are finished, you need to close the launcher and re-open Terminal.

Run the following commands:

```
# cd ~/Minecraft/Natives && wget https://
www.dropbox.com/s/4oxcvz3ky7a3xbf/liblwjgl.so
# wget https://www.dropbox.com/s/
m0r8e0ljg2og3bz/libopenal.so
```

```
# cd /home/pi/.minecraft/libraries/org/
lwjgl/lwjgl/lwjgl/2.9.4-nightly-20150209 &&
```

```
rm lwjgl-2.9.4-nightly-20150209.jar
# wget https://www.dropbox.com/s/
mj15sz3bub4dmrb/lwjgl-2.9.4-nightly-20150209.
jar
```

```
# cd ~/Minecraft/
# wget https://www.dropbox.com/s/
jkh58apwa7ptlw/run.sh
# sudo chmod +x run.sh
```

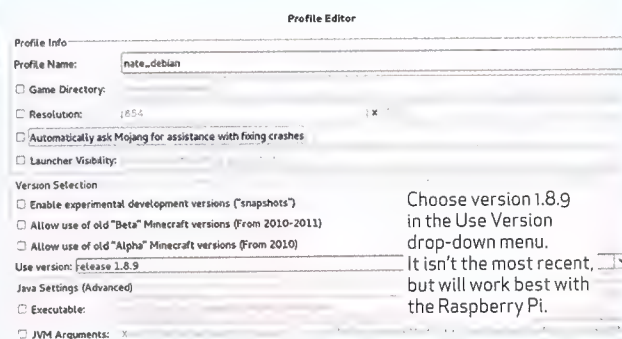
Next, we need to make some changes to one of the files we've downloaded with the following:

```
# sudo nano ~/Minecraft/run.sh
```

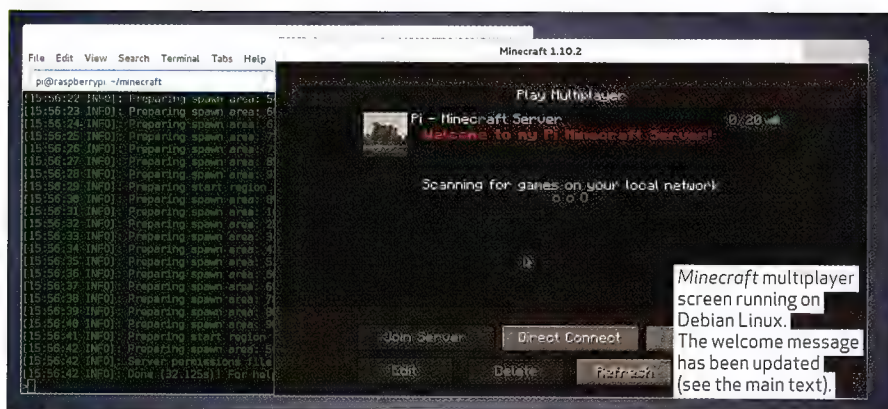
Scroll down with the arrows, and after the '=', enter your *Minecraft* personal details: email, username and password. Press 'Ctrl-X' when you're done, then press 'Y' and Enter to confirm the changes.

To run *Minecraft* at any time, just enter the following command:

```
cd ~/Minecraft && ./run.sh
```



Choose version 1.8.9 in the Use Version drop-down menu. It isn't the most recent, but will work best with the Raspberry Pi.



structures and learn to code, without the extra features of the full *Minecraft* client, then it's ideal.

Although we've seen it's possible to get the full version of *Minecraft* 1.8.9 running on a Raspberry Pi 3 (see the boxout back over the page), the method isn't officially supported by Mojang. This means that you're likely to see reduced performance over a regular desktop machine, such as glitches and crashes some of the time.

The experimental graphics driver that has to be enabled on the Raspberry Pi to use the full version of *Minecraft* stops the official *Minecraft* Pi client from working, but you can disable it again by running `sudo raspi-config` and then rebooting the machine.

Neither version of *Minecraft* plays particularly well if you're accessing the Pi over VNC, so it's best to play it directly.

If you wish to play the full version of *Minecraft*, you do need to purchase an account with Mojang. If you now have the *Minecraft* bug and want to take it further, read on for details of how to set up your own *Minecraft* server on the Pi, and build your own digital world block by block.

MINECRAFT SERVER

On the previous pages, we discussed how to play *Minecraft* directly on the Pi, partly for fun and partly as an introduction to programming with Python. This part of the tutorial concerns installing the *Minecraft* Server software on the Raspberry Pi 3. This enables others running the *Minecraft* client on their computers to connect to your own online world and play free from thieves and 'griefers'.

Minecraft runs in Java, which is pre-installed in the latest version of Raspbian, meaning it's easier than ever to set up a server. The server has fairly low requirements, but for best performance, we recommend using a Raspberry Pi 2 or 3. With your Pi in hand and a fresh install of Raspbian, connect to it via SSH. Note that the default username and password is

'raspberrypi' and 'pi', respectively. Make a note of your Pi's IP address, because you'll need it later.

Next, create a directory for *Minecraft* and open it with the following command:

```
# mkdir minecraft && cd
minecraft
```

Then download the latest version of SpigotMC, a highly customisable and lightweight version of *Minecraft* Server:

```
# wget https://hub.spigotmc.org/jenkins/job/BuildTools/lastSuccessfulBuild/artifact/target/BuildTools.jar
```

Next, tell the Pi to start building the server tools:

```
# java -jar BuildTools.jar
```

Once the process is complete, you'll see a message stating "Saved as spigot-1.x.x.jar", where 1.x.x is the current version number of Spigot that was downloaded (1.11.2 at the time of writing). Next, start the *Minecraft* Server with:

```
# java -jar -Xms512M
-Xmx1000M spigot-1.x.x.jar
nogui
```

Again, substitute '1.x.x' with the version number of Spigot. The program tells you that you need to agree to the EULA in order to run the server. To do this, type:

```
# nano eula.txt
```

Scroll down with your arrow keys and delete the word `false`. Replace it with `TRUE`. Press 'Ctrl-X', then 'Y' and Return to save your changes.

Start the server software again with the same command as beforehand:

```
# java -jar -Xms512M
-Xmx1000M spigot-1.x.x.jar
nogui
```

You'll see a message stating "Loading Libraries, please wait..." and then some basic information about the game displays. Note that the default game mode is Survival, and you then see the spawn area loading slowly as a percentage. This may restart a couple of times as various levels are spawned. You'll see a message stating 'Done!' once the process is complete.

Now it's time to test your server. Go to a computer with the *Minecraft*

client installed and start the program. On the main screen, choose Multiplayer. Next, click 'Add Server'. Click the box marked 'Server Name' and type a name of your choice — for example, "Pi *Minecraft* Server". Click the box marked 'Server Address' and enter the IP address of your Pi. Click 'Done' when complete. You should now see the *Minecraft* server listed.

Hover your mouse over it and click the blue Play button. When the game loads, feel free to wander around a little and even work through your anger issues by smashing a few blocks to make sure the game responds well. Once you're satisfied, close the *Minecraft* window and return to your SSH client, which is still connected to the Pi. Type `stop` for the time being to stop the server.

You can type `stop` at any time to halt the server if, for instance, you need to make any changes. In future, if you wish to run the server software, connect to the Pi via SSH, then use the following command:

```
# cd ~/minecraft && java -jar
-Xms512M -Xmx1000M
spigot-1.x.x.jar nogui
```

Again, replace '1.x.x' with the actual version number of Spigot you currently have installed. If you're unsure of this, type the command `cd ~/minecraft && ls` to view the contents of the `minecraft` folder — you can then see the version of 'spigot-1.x.x.jar' in there.

BASIC SETTINGS

Once the server is up and running, it's time to look at how you can tweak some of the settings. The basic settings are contained in a file named 'server.properties'. You can view and edit this file by running the command:

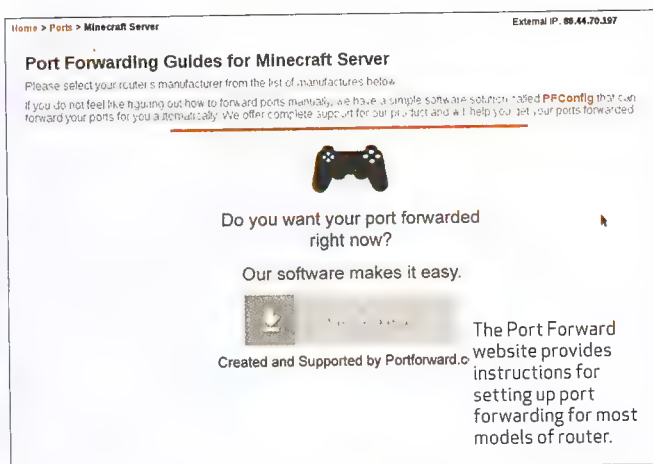
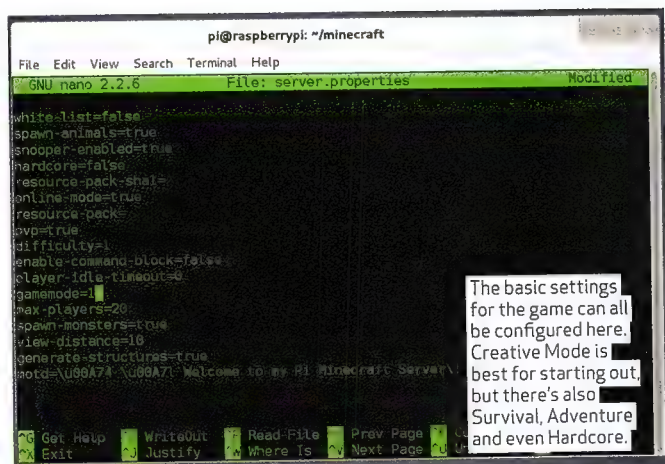
```
# cd ~/minecraft && nano
server.properties
```

If you're intent on fine-tuning your *Minecraft* world, visit <http://minecraft.gamepedia.com/server.properties> to view all values for all potential settings. For now, we're just making some basic changes. Scroll to the very bottom of the file to the value `motd=` using your cursor keys. This is simply the message that appears when you first connect to the *Minecraft* server. By default, this simply says 'A *Minecraft* server'.

Delete the line of text and replace with the following cheery message:

```
motd=\u00A74 \u00A71 Welcome
to my Pi Minecraft Server\!
```

Another change you may want to make to the server — especially for people new to *Minecraft* — is to change the game from Survival Mode to Creative instead. Creative Mode allows for an infinite amount of building materials. Players also don't become hungry or lose energy, so are free to start making their constructs right away.



Scroll up to `gamemode=0` and change the 0 to 1 to do this. Make sure also to change `force-gamemode=false` to `true` to be certain that everyone who logs on in the future will be in Creative Mode.

If you're determined to stay in Survival Mode but want to start off slowly, consider changing `spawn-monsters=true` to `false`. You can also change the game's difficulty by changing `difficulty=1` to a value between 0 and 3, with zero being the easiest difficulty level.

When you are satisfied with the changes that you've made, hit 'Ctrl-X', then 'Y', then Return to save your changes and boot the server.

ADVANCED TWEAKS

As you become more comfortable with playing *Minecraft*, or if you're already an experienced player, you may find the basic configuration options in 'server.properties' limiting.

This is where SpigotMC really comes into its own, with an advanced configuration file. There's a number of tweaks to improve your *Minecraft* experience. Simply stop the server, then run the following command:

```
$ cd ~/minecraft && nano spigot.yml
```

By way of an example of how finely tuned Spigot is, scroll down to where

it says `zombie-aggressive-towards-villager: true` and change it to `false`. This setting determines whether or not zombies will attempt to kill *Minecraft* villagers. The Pi requires fewer AI resources for 'friendly' zombies, so this may speed up your server.

A complete list of the various settings that can be changed in Spigot, along with full descriptions of what they do, can be found at www.spigotmc.org/wiki/spigot-configuration.

SERVER SLOWDOWN

Your configuration may now be tweaked to your heart's content, but as more players join, and more complex structures are created, you may find *Minecraft* slowing down. As we've previously discussed, one way to make sure there is plenty of free space is to move the *Minecraft* folder to an external drive. The syntax of the command is:

```
$ sudo mv ~/minecraft /media/pi/MYUSB
```

Where `MYUSB` is the name of your USB stick.

Bear in mind that the above commands for running the software include the `cd` command, which refers to the `minecraft` directory in the home folder, so make sure to modify the commands accordingly –

for example, `cd ~/minecraft` becomes `cd /media/pi/MYUSB/minecraft`.

If you're still having trouble, try starting the server with the following command which, without going into technical details, instructs Java to make better use of your CPU:

```
$ cd ~/minecraft && java -jar -Xms512M -Xmx1008M -XX:+UseConcMarkSweepGC -XX:+UseParNewGC -XX:+CMSIncrementalPacing -XX:ParallelGCThreads=2 -XX:+AggressiveOpts -jar spigot-1.x.x.jar nogui
```

For even better performance, consider editing the 'server.properties' file once again, this time reducing the view-distance from 10 to 5. This determines how much of the map has to load as you move around. You can also alter `max-players` to change the number of people who can be logged in at the same time.

Going global with *Minecraft*

This tutorial explains how to set up *Minecraft* on your local network, meaning anyone who wants to play will need to be connected to it. However, you may wish to allow others to join your server over the internet.

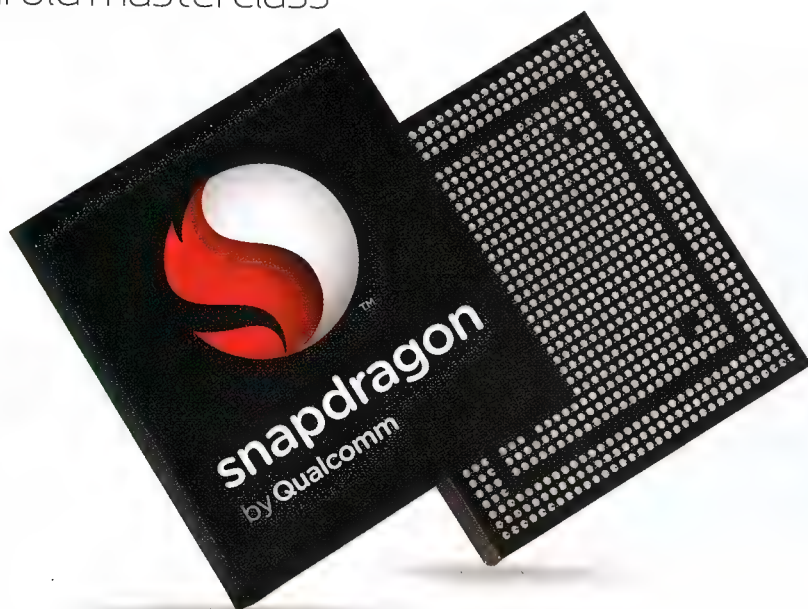
First, you'll need to assign your Pi a permanent IP address on your network by editing '/etc/network/interfaces'. Next, use a feature known as port forwarding on your router to forward incoming traffic from the outside internet to the Pi itself.

Because each router is different, it's best to check the specific steps to do this with your router manufacturer, or enlist a more technically able friend. In either case, say that you need

to open port 25565 for both TCP and UDP. You also need your router's external IP address, which you can get by visiting www.whatismyip.com.

The Port Forward website has multiple guides for setting up port forwarding: http://portforward.com/english/applications/port_forwarding/Minecraft_Server.

Your ISP may change the IP address of your router from time to time, which could cause difficulties for people playing. You can pay to rent a static IP from your ISP or get a free one from a service such as www.noip.com. ■



Qualcomm is releasing new Snapdragon 600-series SoC for mid-range devices.

Where to next for Android?

Darren Yates looks over the horizon to discover the next-generation hardware heading to new Android devices in 2017 and 2018.

We've said it a couple of times now, but if you want to know more about the phones you're going to see next year (and even later this year), take a look at the hardware components beginning to roll off the production line right now. Next-generation SoCs (System on a Chip) give a pretty decent idea of what we can expect in future devices and two key features at the moment are improved battery life and artificial intelligence.

EXYNOS 8895 VS SNAPDRAGON 835

There's been plenty said about the new Samsung Galaxy S8 phone, but often

just cursory glances towards the SoCs available to the new flagship model – Samsung's own Exynos 8895, with twin quad-core clusters running Exynos M2 and Cortex A53 cores, or the new Qualcomm Snapdragon 835, rocking eight Kryo 280 cores in two four-core clusters. While substantially different in the engine department, they have one significant feature in common – they're both made using a 10-nanometre production process (tinyurl.com/kvasnd2).

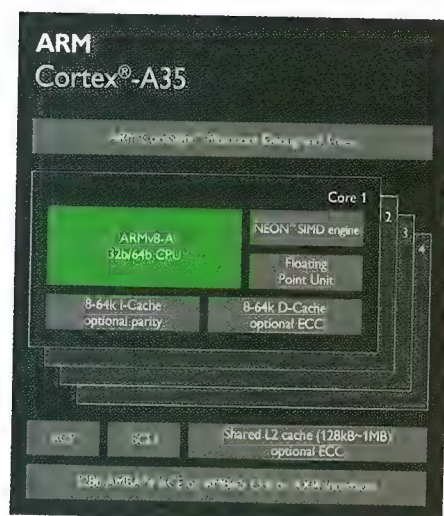
Big deal, you might reckon. Well, actually, it is a big deal. Right now, the latest Intel Kaby Lake-codenamed seventh-gen Core CPUs are made on a 14-nanometre scale, so too AMD's hot new Ryzen chips with their Intel-

performance-matching Zen architecture. While we've seen the odd rumour of 'sluggish' 10-nanometre chip production, it's still a big tick for Samsung that its latest FinFET manufacturing process can churn out transistors that are basically half the size of those from the traditional PC CPU rivals.

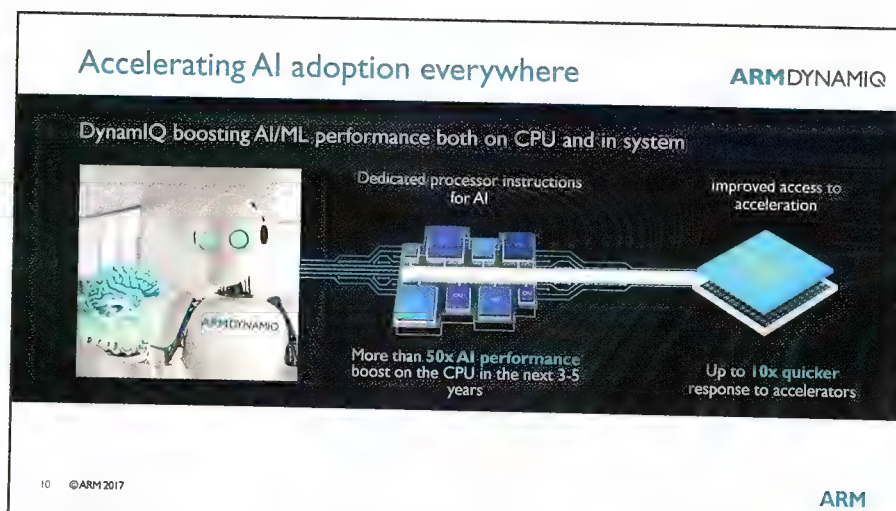
Early performance benchmarks of the 8895 and the Snapdragon 835 (which also powers the new HTC U11 phone) seem to suggest the balance lies slightly in the Exynos' favour.

ARM DYNAMIQ

Meanwhile, artificial intelligence or AI is fast becoming the buzzword business hopes will drive ever-greater efficiency over the next decade, as demand for



The Cortex A35 ultra-efficient 64-bit chip finds a home in the new Helio X30.



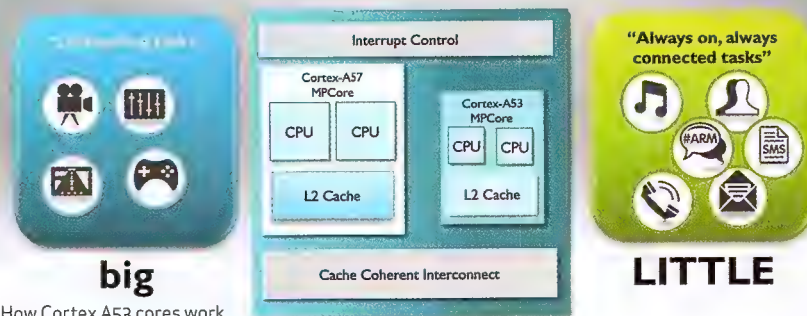
Artificial intelligence is driving mobile chip design over the next five years.

machine learning, data mining and real-time data seeps into almost every field of endeavour. Throw in growth in virtual and augment reality (VR/AR) and mobile computing processing requirements are seriously ramping up.

Since the release of the Cortex A15, ARM has offered mobile SoC makers a technology platform called 'big.LITTLE', whereby two different Cortex A-series core family clusters can combine into the one system. It started off with the Cortex A15 (big) and Cortex A7 (LITTLE) and more recently continues with the Cortex A72/73 (big) and Cortex A53 (LITTLE). These Cortex core families can power SoCs individually, but combined together, it allows a device, in this example, to use the more power-efficient A53 cores for lighter tasks and crank up the A72/A73 cores for higher-demand applications as required.

But recently, ARM announced the next generation of big.LITTLE, aiming it squarely at improving AI performance. It's called 'DynamIQ' and gives the big.LITTLE architecture a far more fine-grained control over how Cortex cores are integrated, powered and operated within an SoC that's called 'heterogeneous computing' (tinyurl.com/lrn854n). DynamIQ will allow device makers to go for a 1+3 (quad-core), 1+7 (octa-core) or even a 2+6 (octa-core) design, but with each core having its own power and performance specs. Yet according to ARM, DynamIQ is expected to also deliver a massive 50X-boost to artificial intelligence performance over the next five years compared with current Cortex A73

Cortex-A53: LITTLE CPU in a big.LITTLE System



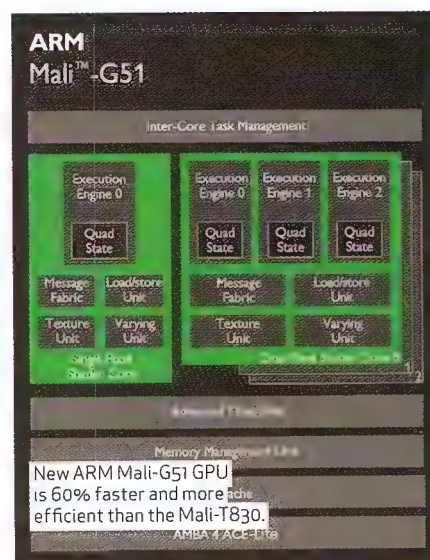
How Cortex A53 cores work in big.LITTLE clustering with A57 cores.

The Architecture for the Digital World® **ARM**

devices. It's an almost insane performance increase and clearly aimed at the boom in autonomous applications, AR/VR and the like.

Part of the problem SoC designers face is that the physical package of a chip can only handle so much heat production, what's called its 'thermal capacity'. ARM says that, by allowing each core to be custom-configured, SoCs will be able to maximise the processing capability of the chip package's thermal capacity (tinyurl.com/mmo4q8l).

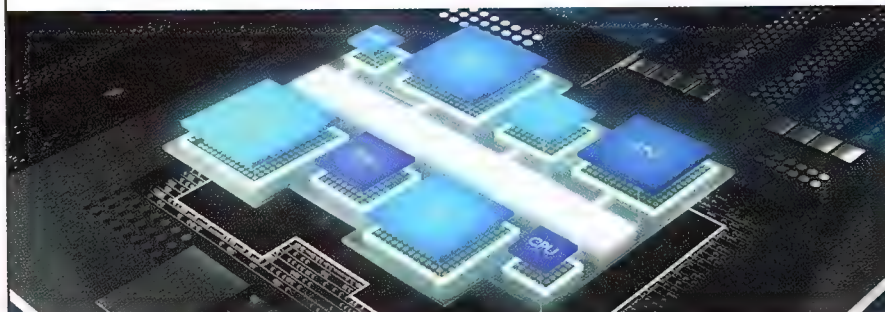
What does this all mean for mobile devices? While certainly making smaller transistors is key to reducing overall power consumption, the ability of SoCs to maximise the thermal capacity they've got means also maximising performance and battery life — the best of both worlds. If you're



"Throw in growth in virtual and augment reality (VR/AR) and mobile computing processing requirements are seriously ramping up."

ARM DynamIQ: Multicore redefined

ARMDYNAMIQ



New single cluster design

Greater flexibility with or without big.LITTLE

Redesigned memory sub-system

Advanced compute capabilities

© ARM 2017

ARM

DynamIQ allows SoCs to be designed with independent cores.

LG's G6 phone already has support for HDR10 video content playback



The replacement for this Moto X will likely run the Snapdragon 660 SoC.



The Galaxy S8 has chips with smaller transistors than Intel or AMD chips.

"If you're considering a new phone later this year, you might want to keep your cash in your pocket until we see which phones feature the Snapdragon 660 and the hardware bundled with them."

hanging around for your next phone to feature better battery life, it'll be techniques like this that get you there.

COMPUTER VISION

It's not an area that grabs the headlines like VR or autonomous cars, but computer vision is a hot-button topic in research circles right now at both industry and university level, for without image processing (from signal processing to data mining), applications like VR and autonomous cars just don't work.

ARM earlier this year released what it calls the ARM Compute Library, a code library for implementing fast, low-level maths functions and machine-learning algorithms on mobile GPUs. The concept is similar to what Nvidia has been pushing on CUDA cores, but now comes to late-model ARM Mali-class GPUs – that should include devices with Mali-T600/T700/T800-series or the newer G71/G51 GPUs. You'll be able to implement OpenCL code more simply through the ARM Compute Library (tinyurl.com/kjlq4d8).

Since GPUs are designed to perform small-scale repetitive calculations at speed, they're ideal for handling tasks like image processing, computer vision and sophisticated machine learning algorithms such as convolutional neural

networks. More recently, ARM has also introduced the Mali-C71, an image processor specifically designed for automotive applications, such as autonomous cars.

QUALCOMM SNAPDRAGON 630/660

In the meantime, while we're waiting for DynamIQ, we won't be short of new SoCs hitting the market. ARM chipmaker Qualcomm has been busy readying product for the mid-range SoC sector, announcing two new models likely to appear in devices released over the next six months.

The Snapdragon 660 is expected first off the rank and will be manufactured on a 14-nanometre scale. It's a straight-eight Qualcomm Kryo 260 core design with clocks at up to 2.2GHz. As far as we're aware, this is the first time Qualcomm has brought its Kryo tech into the mid-range market, so it's a significant move. The 660 appears to replace the Snapdragon 653 and its twin set of four Cortex A72 and four A53 cores in big, LITTLE configuration. The new SoC also packs in the Adreno 512 graphics core, delivering 30% faster graphics than the Snapdragon 653.

The slightly lower-rated Snapdragon 630, by contrast, will run eight standard ARM Cortex A53 cores at up to 2.2GHz

and is made on the same production scale as the 660, but with a slightly slower Adreno 508 GPU core. That said, you should still get 30% more graphics speed than its predecessor.

Otherwise, both SoCs now feature two Qualcomm Spectra 160 image sensor processors, able to handle one 24MP or two 16MP cameras for AR/VR applications and with zero shutter-speed lag. In terms of video, both SoCs are 4K-ready, recording at 30fps and will do 1080p-recording at up to 120fps. On the connectivity front, Qualcomm's X12 LTE modem inside both offers peak download bandwidth of 600Mbps and uploads to a maximum of 150Mbps, making it the same speed the older Snapdragon 820. They also both support USB 3.1/Type-C and come with Qualcomm's QuickCharge 4 fast-charging system that will give a half-capacity battery charge in as little as 15 minutes.

Rumours are Motorola's 2017 Moto X will feature the 660 SoC – along with an enormous 3,800mAh battery and twin cameras. Phones built on the 630 aren't expected before August, but rumours suggest they'll have "all-day battery life".

Bottom line, while the 630 is being seen as an evolutionary step, the 660 could be a serious game-changer – it looks to pack in not only quite decent performance, but 4K video recording and image processing from previous flagship phones. Or in other words, what was previously considered 'flagship' in 2016 is to become merely 'mid-range' by the end of 2017. So if you're considering a new phone later this year, you might want to keep your cash in your pocket until we see which phones feature the Snapdragon 660 and the hardware bundled with them. We could see phones under \$400 for exceptionally good value.

EIGHT ISN'T ENOUGH

But eight-cores is 'so 2016' to some, particularly in light of the new 10-cored Helio X30 SoC from MediaTek. It's the first distinct tri-cluster design we're aware of in the consumer market – two Cortex A73 cores clocking at 2.5GHz, four 2.2GHz Cortex A53 cores and, uniquely, four Cortex A35 cores at 1.9GHz.

The Cortex A35 is ARM's first "ultra-efficient" 64-bit core design, so not particularly fast compared with the Cortex A73, or even the A53, but it should run off the proverbial smell of an oily rag. Previously, MediaTek's deca-core X25 and X20 SoCs have gone with twin Cortex A72 and eight Cortex A53 cores, but with four of those A53 cores as a third cluster running at a considerably lower 1.4–1.55GHz to achieve greater efficiency. But like the Snapdragon 835 and Exynos 8895, the new X30 is a 10-nanometre chip – according to MediaTek, it all gives the X30 a 50% power consumption reduction and a 35% performance gain compared with the previous-gen X20 (tinyurl.com/lh2fppe).

Like the new Snapdragon 630/660 SoCs, the X30 uses carrier aggregation to boost LTE network speeds, but only achieves a 450Mbps download peak, against the 600Mbps peak of the X12 LTE modem in the Snapdragon parts. Otherwise, it's also a dual-camera-ready option with support for either a single 28MP camera or dual 16MP sensors. Expect it to compete in the crowding 4K video market, with 4K video recording and playback to 30fps and support for HDR10 content.

The question we have is whether a 10-core SoC with only two high-performance cores can match an eight-core SoC with four performance cores. Some are suggesting the X30 is a rival to the Snapdragon 835, but we can't help but wonder if it's more likely to compete against the Snapdragon 660. Still, we'll have to wait until they begin arriving in numbers to know for certain.

NEW ARM DISPLAY PROCESSOR

ARM also recently took the covers off its next-generation video display driver core. Codenamed 'Mali-Cetus', it's not a new graphics processing unit (GPU), but rather, controls the output to a device's display panel. ARM doesn't release a new one of these very often, so it's a bit of a big deal. The two key features here are the ability to support HDR10 high-dynamic range (HDR) video, plus a from-the-ground-up design for 4K and VR. That 4K-resolution support goes up to 90fps and HDR video is one of the key-selling features in the 2017 big-screen TV market, with HDR10 up against Dolby Vision. Throw in HLG (hybrid log-gamma) and ARM-class

video is clearly getting a spruce up. HDR is fast becoming the new battleground for TV makers and it's no surprise the arrival of Android 7.0/Nougat brought with it support for HDR content. In fact, Nougat can handle everything from Dolby Vision through to HDR10, HLG and PQ, based on Google's VP9 video codec.

LG's G6 is one of the few current phones to support Dolby Vision and HDR10, so you can be sure HDR support is a function of both hardware and OS readiness.

2018-GENERATION SOCS

While 10-nanometre scale production is the headline act at the moment, that'll drop to 7 nanometres in 2018. So far, Taiwanese-based chip foundry TSMC and its competitor GlobalFoundries are reportedly gearing up for 7-nanometre production based on new ARM core technology for a 2018 start. Many of those new SoCs are likely to also feature equally new GPUs, thanks to the arrival of ARM's Mali-G51. A mid-range counterpoint to the flagship Mali-G71 Bifrost-class GPU, the G51 nevertheless claims to be 60% faster and more power efficient than the Mali-T830 it replaces.

With Android 8 expected before October this year, it's actually looking

like the mid-range market could see a real jump if all the pieces fall into place. There's no doubt AR/VR will be a driving force for Android over the next couple of years, but with ARM's plans for DynamIQ and AI, the term 'smartphone' looks set to take on a whole new meaning.

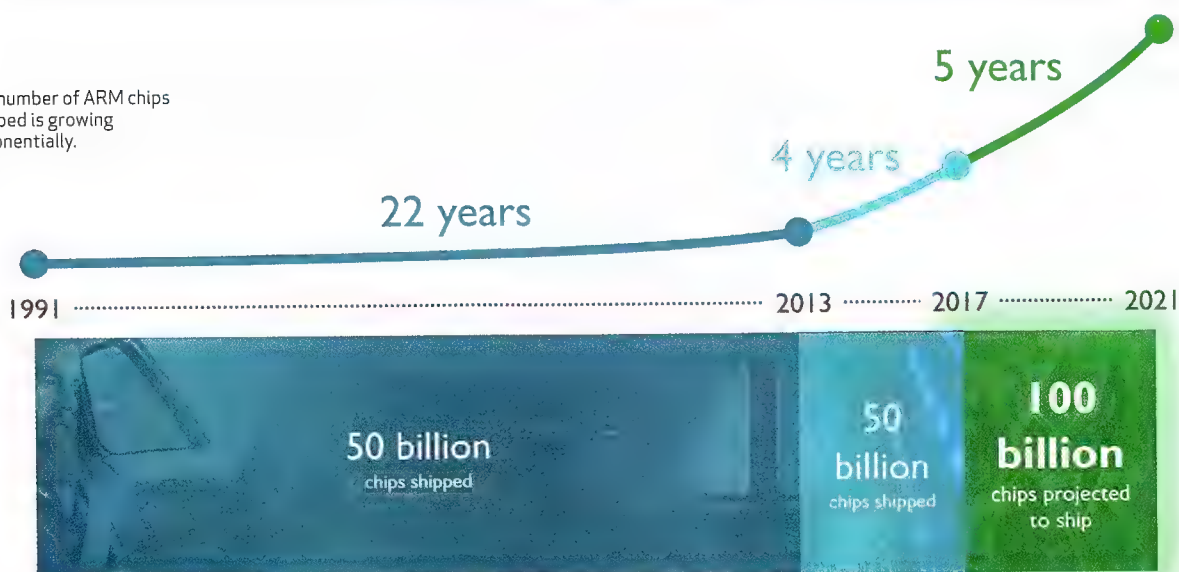
If you look at the Android hardware ecosystem as a whole, it's equally clear we're set to see rapid expansion beyond the mobile handset market. From high-speed gigabit telephony network speeds to machine learning algorithms to automotive image processing to HDR video content – Android-grade hardware is now spilling across into new areas and offering premium applications we only dreamt of a few years ago. You've also got car makers Volvo and Audi looking to increasingly integrate the personal technology of smartphones into car operations, from controlling air conditioning to sunroofs and windows. What's more, they're going beyond Android Auto to a fuller Android OS codebase to do it (tinyurl.com/19rts49).

Up until now, we've been seeing and using smartphones as personal-space devices. With the impending tech arrivals, there's little doubt we're at the beginning of a considerable expansion of the smartphone's field-of-view over the next five years. ■

"If you look at the Android hardware ecosystem as a whole, it's equally clear we're set to see rapid expansion beyond the mobile handset market."

Extraordinary growth of compute – from chip to cloud

The number of ARM chips shipped is growing exponentially.



Make a Wi-Fi internet clock — Part 2

Darren Yates continues his introduction into Internet of Things hardware, building an internet clock with built-in Wi-Fi and OLED panel.

Last month, we introduced the NodeMCU Development Kit, a \$5 maker board with 802.11b/g/n Wi-Fi, built around the popular ESP8266 Wi-Fi microcontroller. The fact you can code it via the standard Arduino integrated development environment (IDE, www.arduino.cc/downloads) also makes it ideal for learning to make your own Internet of Things (IoT) gadgets. We'll continue this month with making an automated Wi-Fi internet clock with OLED display.

NODEMCU AND BREADBOARDS

There are a few NodeMCU-style boards on the market, the 'LoLin' being one of the cheapest. But this particular board has an issue — the width requires the full width of a standard 400-point breadboard. That means the only way you can plug wires into it is to use special insulated breadboard bridging jumpers that fit underneath the NodeMCU board. The good thing about the LoLin board, though, is it has no components on the underside, so insulated jumper wires fit comfortably. We recommend you buy a '140-piece breadboard jumper wire kit' featuring different lengths of insulated solid-core jumper wire — eBay has these for \$4 or so and they're perfect. You want the jumper wires sitting as flat to the breadboard as possible. Follow the wiring diagram above, the NodeMCU and OLED panel then just slot into place (we added some double-sided tape to the back of the OLED panel to ensure isolation).

Use insulated jumper wires on the 400-tiepoint breadboard for this project.

128 X 64 OLED DISPLAY

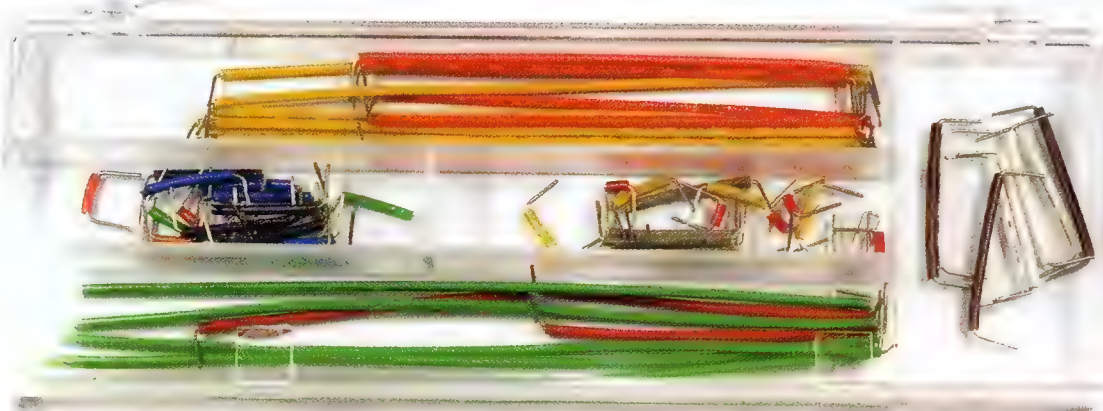
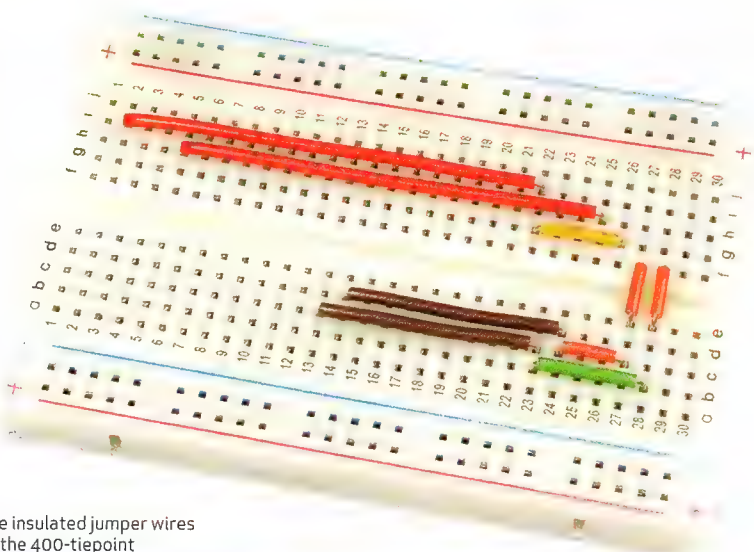
One of the tricky things with the ESP8266 is that it runs on 3.3VDC voltage, not the usual 5VDC used by standard Arduino boards such as the Uno or Nano (the NodeMCU board has a voltage regulator to convert the USB's 5VDC down to 3.3VDC). The lower voltage can be a problem for many Arduino-ready displays designed to work on 5VDC and, in fact, try them here and many won't work, simply because 3.3VDC is too low.

One display panel we like is the 128 x 64-pixel I2C OLED display available on eBay. For around \$5, it delivers text and graphics while only requiring two data pins (the inter-integrated circuit or I2C bus). But the other great thing is that it

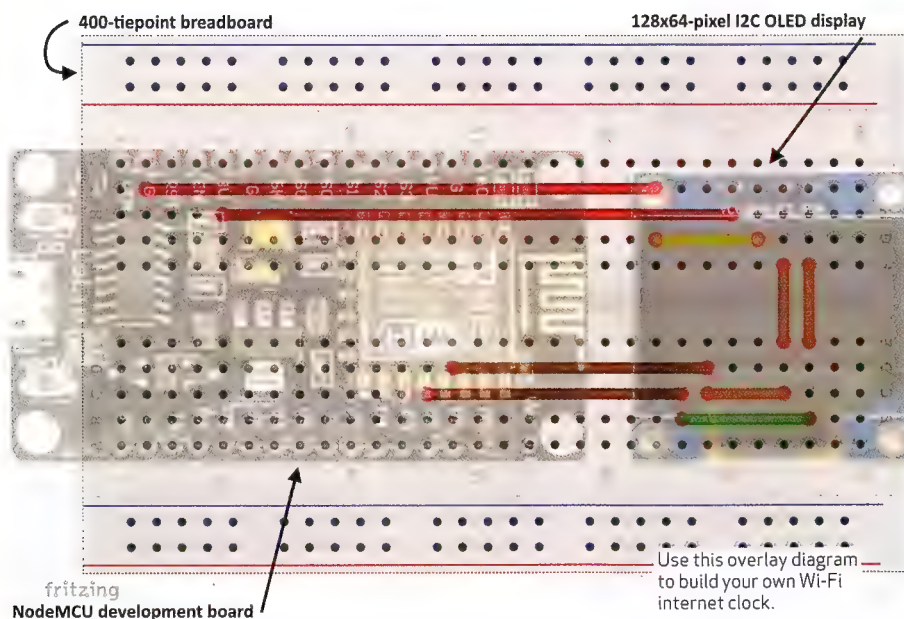
works on 3.3 and 5VDC, so it's right at home plugged into the NodeMCU.

CLOCK CODE

The secret sauce for our clock is the wificlock.ino source code you'll find on the APC website (www.apcmag.com/magstuff). As we mentioned last time, Network Time Protocol (NTP) is a global network standard for time-synchronising computers together and the ntp.org project provides free-access public servers for IoT devices to keep time. To make our Wi-Fi internet clock, we've taken the 'NTPClient' code example from the NodeMCU library and modded it, switching from the US to the Australian time server pool and including the OLED library.



You'll find this 'breadboard jumper wire kit' on eBay for \$3.



However, we see two issues with the NTPClient code. First, it hits the time servers every 10 seconds with a 'send time' request. This needs a substantial rewrite to address more permanently, but a crude-yet-simple `delay()` function can push out the request frequency – this we've done, backing it off from every 10 seconds to every 30 seconds. It means your clock will be up to 30 seconds out from internet time, but close enough for a simple time piece.

REDUCING POWER CONSUMPTION

The second issue is that, with this code, the ESP8266 chip runs continuously at full power. That won't matter much while it's plugged into your mains-powered PC, but if you're running off a battery, the 80mA power consumption will kill a 2,000mAh battery in a day.

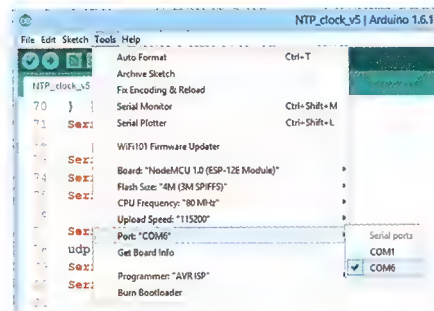
Just like the CPU inside your PC, almost all microcontrollers have low-power modes to reduce consumption for when they're not needed to run full-tilt. The main power draw on the ESP8266 is the Wi-Fi transceiver, the radio section sending and receiving data. What we need is a low-power mode that switches off the Wi-Fi but keeps the CPU section running. If you look through the

wificlock.ino code, the command for this is: `WiFi.forceSleepBegin()`; And to wake up the Wi-Fi engine, we use: `WiFi.forceSleepWake()`;

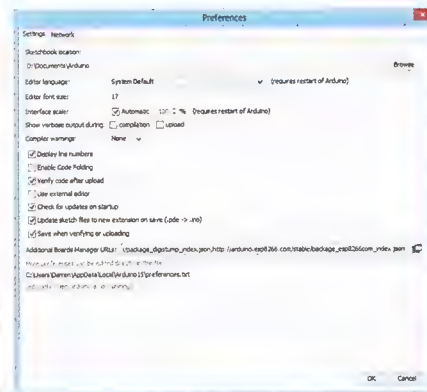
However – each time you shut down the Wi-Fi engine, you lose your network connection. Re-establishing the link on 'wake' happens automatically, but this takes a few seconds to complete, so it's not an 'instant-on' thing. Doing this means power consumption drops from around 80mA to nearer 30mA (and that's mostly the OLED display). The ESP8266 does have a couple of sleep modes – the mode we're using keeps the CPU core running at full speed. Then 'deep sleep' suspends most of the core until a 'wake' interrupt triggers, so on balance, our chosen mode achieves maximum power drop whilst maintaining full core performance.

SETTING UP NODEMCU LIBRARY

You need to import the NodeMCU library into the Arduino IDE before you can write code to the board. To do so, launch the IDE and, from the menu, select File, Preferences and in the 'Additional Boards Manager URLs', add the text: http://arduino.esp8266.com/stable/package_



Make sure to select the correct COM port before trying to flash your code.



Choose File, Preferences and add the link to import the NodeMCU library.

esp8266com_index.json

Press OK. Next, from the menu, choose 'Tools', select 'Board', 'Boards Manager'. Type "ESP8266" in the search box and look for 'esp8266 by ESP8266 Community'. Move your cursor over the entry and press the Install button. Next, click 'Close', then shut down all open instances of the Arduino IDE.

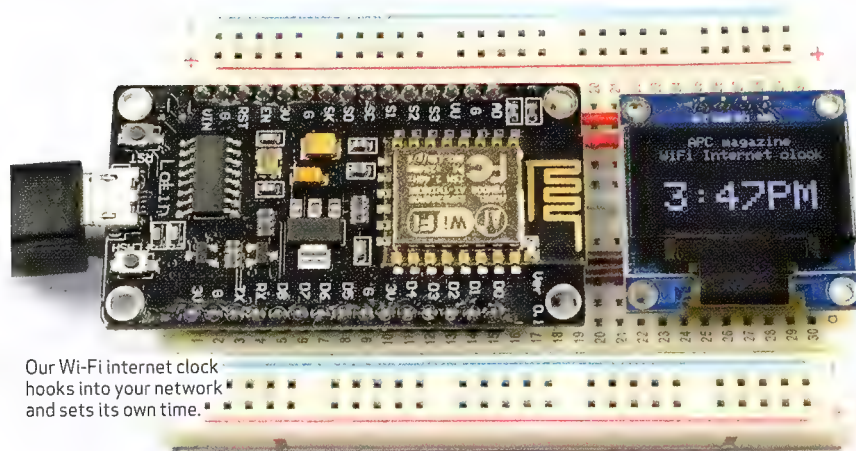
Most Arduino projects require extra libraries, so we've included these in the source code pack, so copy the contents of the 'libraries' subfolder to the same folder in the Arduino IDE location. Once that's done, you can restart the IDE.

FLASHING CODE

To flash the clock code to the board, plug the board into your PC via USB and in the IDE, select 'Tools', 'Boards', scroll down and choose 'NodeMCU 1.0 (ESP-12E module)'. After that, you again choose from the menu 'Tools', 'Port' and select the 'COMx' option that isn't COM1 (that'll be your mouse). Load up the wificlock.ino code, enter into the source code the SSID name and password for your wireless network, plus the appropriate UTC time offset for your location, hit the 'Upload' button and watch it upload. After about 10 seconds or so, the current local time should appear on the OLED panel.

HAVE A GO

There are any number of projects you can build using the NodeMCU board – so get hold of one and start making your own! ■



Learning Python: The secrets of cryptography

Darren Yates continues his Learning Python coding series with an introduction to cryptography, the Enigma cipher machine and the Lorenz SZ40.

By June 1940, Hitler's armed forces had secured victory over France and World War II was now on Britain's doorstep. Later that same year, prominent mathematician G.H. Hardy wrote in his essay 'A Mathematician's Apology' that "real mathematics has no effect on war". Hardy apparently didn't think much of applied maths, but it's unlikely, given the secrecy of the time, that he knew the extent to which maths was playing a major part in hacking the new top-secret technological wonders being developed.

The exploits of Bletchley Park are today still shrouded in mystery, with reports that some of the work carried out is still restricted more than 70 years after the event. But the lessons learned continue to teach us about cryptography, and this month, we'll attempt to code not just the Enigma machine, but also the more-advanced Lorenz SZ40, the machine that led to the development of the world's first all-electronic computer.

CRYPTOGRAPHY RULES THE WORLD

Without data encryption, today's online

economy simply collapses – everyone can see your bank account details, read your email and hack your devices. But while early cryptography efforts involved alphabet substitution and relied primarily on literary knowledge, World War II marked a turning point, where the art of cryptography became a modern science based on mathematics.

ENIGMA CIPHER MACHINE

The Enigma machine is an electromechanical symmetric-key cipher machine that encodes plaintext into a stream of apparently random characters. That stream is repeatable, depending on how you set up the machine. Set it up a certain way and encode your plaintext message; set it up the same way again and typing in the encoded ciphertext reveals the initial plaintext message. The symmetry comes from the fact the same key settings are used to encode and decode the message. Electrically, Enigma is nothing more than wires, switches, plugs and lamps, but the continually stepped rotors, combined with the front plugboard for swapping letters, provided over 150 million million different setup options.



The Enigma cipher machine was famously hacked (with help) by Alan Turing.

We showed you a few years ago (August 2013, tinyurl.com/lzuwhkl) how to build a complete Enigma M3 cipher machine using an Arduino microcontroller board, a 16x2-character LCD panel and a PS/2 keyboard. It was a standalone device coded in a form of the C programming language. Can it be done in Python?

CODING ENIGMA IN PYTHON

If you can code a function in one language, the chances are pretty decent you can code it in another. Grab this month's Python source code pack from our website (www.apcmag.com/magstuff), plus the Python 3.6 IDE (www.python.org/downloads) and open up the 'enigma.py' source code in the IDLE editor. The code emulates the Enigma M3 machine used by the German army during the war, including the rotor wiring used in the actual machine. It's also much more efficient than our original Arduino code.

Enigma.py has six main sections. First, there's the list of arrays that emulate the rotor wheel wiring and rotor stepping notches. That's followed by the five functions that carry out the main tasks in encoding/decoding an Enigma message. The first of these is 'rotateRotors()'. Each time a key is pressed, the rotors advance

```
Python 3.6.0 Shell
Python 3.6.0 (v3.6.0:41df79263a11, Dec 23 2016, 07:18:10) [MSC v.1900 32 bit (Intel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: C:\Users\Darren\Python Code\enigma_v4_FINAL.py =====
----- Darren's Python Enigma Cipher Machine -----
Enter the rotor order (choose 3 of 5 eg. 135, <enter> to quit: 531
Enter rotor start 'Grundstellung' positions (eg. APC) : APC
Enter rotor offset 'Ringstellung' positions (eg. MAG) : MAG
Enter up to 10 plug pairs (eg. 'DY,AP,CM' - no duplicates) : DY,AP,CM
Enter your message : PYTHON IS A VERSATILE LANGUAGE SUITABLE FOR MANY PURPOSES
Your encoded message: CLOJDO VC W EOJZKZSRV VIZSBNQQ VMWOEXHG LWQ SWPF JBMZBWJM

----- Darren's Python Enigma Cipher Machine -----
Enter the rotor order (choose 3 of 5 eg. 135, <enter> to quit: 531
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----- Darren's Python Enigma Cipher Machine -----
Enter the rotor order (choose 3 of 5 eg. 135, <enter> to quit:
>>>

Our enigma.py app replicates the three-rotor Enigma machine.
```


Modulo-2/Exclusive-OR Ecrption/Decryption - How it works

APC Cipher Alphabet Code

A	•••••	Q	X••••
B	••••X	R	X•••X
C	•••X•	S	X••X•
D	•••XX	T	X••XX
E	••X••	U	X•X••
F	••X•X	V	X•X•X
G	••XX•	W	X•XX•
H	••XXX	X	X•XXX
I	•X•••	Y	XX•••
J	•X••X	Z	XX••X
K	•X•X•	<spce>	XX•X•
L	•X•XX	#	XX•XX
M	•XX••	@	XXX••
N	•XX•X	\$	XXX•X
O	•XXX•	%	XXXX•
P	•XXXX	&	XXXXX

Random Stream

D
F
E
G
O
C
F
A
P
R
E
Q
B
V
D

Original Message: CODE

original C •••X• O •XXX• D ••XX E ••X••
stream D ••XX F ••X•X E ••X•• G ••XX•
encode B •••X L •X•XX H ••XXX D ••XX

Transmitted Message: BLHD

Received Message: BLHD

encode B •••X L •X•XX H ••XXX D ••XX
stream D ••XX F ••X•X E ••X•• G ••XX•
original C •••X• O •XXX• D ••XX E ••X••

Decoded Message: CODE

Simple example of Vernam Cipher/Modulo-2 maths used by the Lorenz SZ40.

"Enigma is nothing more than wires, switches, plugs and lamps, but the continually stepped rotors, combined with the front plugboard for swapping letters, provided over 150 million million different setup options."

```
Python 3.6.0 (v3.6.0:41df79263a11, Dec 23 2016, 07:18:10) [MSC v.1900 32 bit (Intel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: C:\Users\Darren\Python Code\lorenz-v2-FINAL.py =====
----- Darren's very-pseudo Lorenz SZ40 machine (v2) -----
Enter the message key (up to six letters, eg. APCMAG, <enter>=quit): APC
Enter a short message (alpha characters only): SECRET

Here's how the Modulo-2/X-OR maths worked:
Original Random Output
S ( 00101 ) X-OR ( ^ ) Y ( 10101 ) -> T ( 10000 )
E ( 00001 ) X-OR ( ^ ) L ( 10010 ) -> W ( 10011 )
C ( 01110 ) X-OR ( ^ ) S ( 00101 ) -> J ( 01011 )
R ( 01010 ) X-OR ( ^ ) H ( 10100 ) -> V ( 11110 )
E ( 00001 ) X-OR ( ^ ) N ( 01100 ) -> F ( 01101 )
T ( 10000 ) X-OR ( ^ ) A ( 00011 ) -> W ( 10011 )

Original message: SECRET
De/coded message: TWJVFV

----- Darren's very-pseudo Lorenz SZ40 machine (v2) -----
Enter the message key (up to six letters, eg. APCMAG, <enter>=quit): APC
>>> |
```

The Lorenz.py code combines an XOR function with a random character stream.

```
Python 3.6.0 (v3.6.0:41df79263a11, Dec 23 2016, 07:18:10) [MSC v.1900 32 bit (Intel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: C:\Users\Darren\Python Code\lorenz-v2-FINAL.py =====
----- Darren's very-pseudo Lorenz SZ40 machine (v2) -----
Enter the message key (up to six letters, eg. APCMAG, <enter>=quit): APC
Enter a short message (alpha characters only): TWJVFV

Here's how the Modulo-2/X-OR maths worked:
Original Random Output
T ( 10000 ) X-OR ( ^ ) Y ( 10101 ) -> S ( 00101 )
W ( 10011 ) X-OR ( ^ ) L ( 10010 ) -> E ( 00001 )
J ( 01011 ) X-OR ( ^ ) S ( 00101 ) -> C ( 01110 )
V ( 11110 ) X-OR ( ^ ) H ( 10100 ) -> R ( 01010 )
F ( 01101 ) X-OR ( ^ ) N ( 01100 ) -> E ( 00001 )
W ( 10011 ) X-OR ( ^ ) A ( 00011 ) -> T ( 10000 )

Original message: TWJVFV
De/coded message: SECRET

----- Darren's very-pseudo Lorenz SZ40 machine (v2) -----
Enter the message key (up to six letters, eg. APCMAG, <enter>=quit): APC
>>> |
```

The same method is used to decrypt the coded message, revealing the original.

in a method similar to a car odometer. This function takes into account the key-notches designed to advance the rotors in a more unusual manner.

Next is alphanum(), a simple function that converts an alphabet letter into a number between 0 and 25.

After that is the encodeLetter() function, which does the heavy lifting. It emulates the electrical wiring of the Enigma through eight steps. First, the message character is fed into Rotor 3, the output of Rotor 3 goes into the input of Rotor 2, the output of Rotor 2 goes into Rotor 1 and the output of Rotor 1 is fed into the fixed 'reflector' rotor. Then the return journey – from reflector rotor to Rotor 1, Rotor 1 to Rotor 2, Rotor 2 to Rotor 3 and the output of Rotor 3 is the encoded/decoded character.

The viaPlugBoard() function is used twice (once on the 'outbound' trip and again on the 'return') to swap specified letters, greatly increase the encryption possibilities. Finally, the main() function is the app's top-level code asking the user for the input settings and message, plus delivering the result back to the user.

The most complex function is encodeLetter(), which uses the position or 'index' of a character in each array to determine the next step in the encryption. The rotors on the Enigma don't just set how the machine works, they also visually represent how we count through the array lists in our Python code. Each rotor is a ring of 26 characters – we also count as a round of 26 using Python's modulo (%) function (we'll talk more about modulo mathematics in a moment). It's the reason why just about every code line in that function finishes in '% 26' – it ensures the answer is between 0 and 25, matching the array index range (and the corresponding characters) we're looking for.

LORENZ SZ40

But even before World War II, Enigma was obsolete tech. What's more, it required six support staff to send one message – three on the sending side, three on the receiving side. Hitler also didn't want his top-secret messages going out along the common Enigma channels – he wanted his own 'Geheimschreiber' or 'secret writer'.

The Lorenz SZ40 was the result, an automated radio-teleprinter encipher machine many times more secure than Enigma. You typed in your message, the SZ40 automatically encoded it and transmitted via radiowaves. At the other end, another SZ40 received the transmission, automatically decoded it and printed out the plain text.

The story of how British mathematician Bill Tutte and engineer Tommy Flowers defeated the Lorenz without seeing one still mostly plays out behind Alan Turing's Enigma story, but the SZ40 is incredibly interesting for featuring cryptographic techniques still in use today.

PYTHON'S MODULO-2

Creating an accurate replica of the Lorenz SZ40 is out a little out of our league, but we can create a reasonable substitute in Python that gets the idea across. It uses the main section of the actual ITA2 code (alphabet characters only) and adds, modulo-2, a repeatable stream of random characters with the original message text to create the encrypted text, much as the SZ40 did. The difference here is instead of using the SZ40's complex array of 12 rotors to generate the random character stream, we cheat — using Python's rather less secure but simpler `random()` number generator instead. More importantly, our code displays how the modulo-2 function works on the ITA2 code letters as it goes through encoding/decoding

the plain text/encrypted message. Grab the source code pack again and load up 'lorenz.py'. Now just to be clear, the Python team specifically say don't use `random()` for security applications because it's not purely random, so we wouldn't trust coded messages from here to trouble more than a dead parrot — just consider the code for educational purposes only.

We start by importing the `maths` and `random` modules, then creating the ITA2 alphabet code array, where the index of each character is its five-bit value (array and list indexes start from zero, so 'E' here has the value '1' and so on).

The first function, `char2bin()`, does the tricky job of converting the character's ITA2 index into a five-bit

binary number, again for example, 'E' becomes '00001', 'A' returns '00011' and so on. Following that, the `main()` function does the rest. We ask the user to enter a message 'key' of up to six letters, followed by the short message to encode. We use the key letters to seed the `random()` function, so that each time that key string is used, the random numbers generated by `random.randint()` are the same. The line:

```
codedLetter = ITA2.  
index(letter) ^ ITA2.  
index(randChar)
```

...does the hard work of modulo-2/exclusive-ORing each original message character and stream character together, in turn, with the result stored in the variable 'codedLetter'. When the message loop of all characters is complete, the result is printed to the console/screen.

HOW TO USE THE APPS

The Lorenz SZ40 and Enigma are examples of 'symmetric key encryption', where the same key is used to encrypt and decrypt the original plaintext message. Using the Lorenz Python app is pretty straightforward — to send a message, you and a mate both need a copy of the app running on the Python IDE and a single shared six-letter-max key text. Next, type in your message, the coded text comes out and you send that to your mate. He types in the same key text, then the coded message and out comes the original plaintext.

Encoding messages on the Enigma app is a little more complex, but not much — start by choosing three of five rotors (such as 235), set the rotor 'starting' or 'ground' positions as a three-letter group (like APC), followed by the internal rotor ring offset settings, again with a three-letter group (MAG). Finally (and optionally), you can add up to 10 character 'pairs', each separate by a comma — these mimic the plugboard on the original Enigma for swapping letters to further diffuse the cipher. When entering the character pairs, each letter can only ever appear once. Next, type in your plaintext message. As soon as you press enter, the coded text will appear. Send that to your mate. At the other end, your mate sets up their Enigma Python app with exactly the same settings, types in the encrypted text, presses Enter and out comes the plaintext.

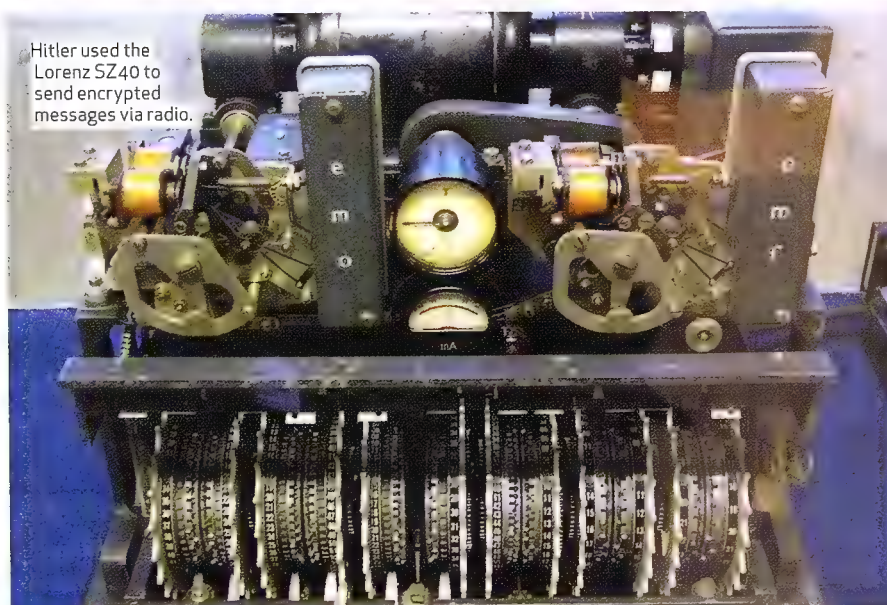
GIVE IT A GO

In World War I, codebreakers were mostly drawn from linguists and language experts. In World War II, they were increasingly mathematicians. Today, our world relies on secure communications using very complex mathematical encryption systems, like SHA (Secure Hash Algorithm). But there's still plenty that the original 'symmetric key' encryption systems like Enigma and the Lorenz SZ40 can teach us. ■

"Hitler required a hack-proof encryption system that was fast and reliable. The solution was something similar to Enigma but with an extra twist."



The 12 rotors inside the SZ40 create a pseudo-random stream of characters.



Hitler used the Lorenz SZ40 to send encrypted messages via radio.

downtime

GAMES: EDITED BY CARMEL SALLEY

www
apc
RECOMMENDS

The Gloo Cannon can trap enemies in place for an easier kill or it can create Gloo platforms to reach inaccessible areas.

PC, PS4, XO | \$99.95 | PREY.BETHESDA.NET

Prey

This franchise reboot turns out to be a very welcome shock to the system.

One of the surprise pleasures of this video game generation is the re-emergence of the 'immersive sim'. Lately, we've been spoiled with a handful of detailed, systems-oriented RPGs, but that's likely to change soon. Mediocre sales for the genre across the board (such as *Deus Ex: Mankind Divided* and *Dishonored 2*) are unlikely to encourage publishers, but we've at least seen one of the best in recent memory in *Prey*.

This is Arkane's "reboot" of the classic first-person shooter, but it has no real relationship with that older game except for the brand. Instead, *Prey* is basically a *System Shock* instalment in all but name.

As protagonist Morgan Yu (who can be either male or female), you awaken to discover that your whole world isn't quite what it seems. You're living on a giant space station and not

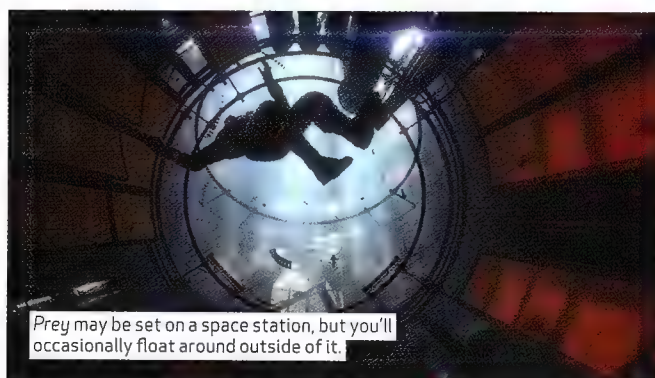
on a futuristic planet Earth. Never mind, though, because everyone complicit in blindfolding you appears to be dead (which is good) or else morphed into shape-shifting alien lifeforms (which is bad). You'll navigate the massive suspended station in order to stop the latter from escaping and wreaking havoc on human civilisation.

The opening hours of *Prey* are slow, and it takes roughly five hours or so before the game's best abilities are accessible. These include

technology which allows Morgan to transform into any inanimate object, in order to access otherwise inaccessible regions of the map. There are more of these powers to be unlocked but they're rarely as liberating as the super powers found in *Dishonored*. This is no bad thing, though: *Prey* is altogether a more slow-paced meditative game, so densely packed with rich narrative details that you'll appreciate the opportunity to explore the Talos 1 space station inside and out.

Still, it's not as meditative as it could be: the combat isn't terrible, but it's something you'll learn to dread. The various enemies are difficult to aim at and take a lot of scarce firepower to fell. Meanwhile, evading them stealthily feels less viable than it should be. But these elements only serve to strengthen the eerie, survival horror-leaning atmosphere, and smarter players will learn to implement the environment rather than brute force in order to deal with foes. You'll learn the environment inside and out as you navigate the wasted, decrepit utility tunnels and majestic lobbies, and what it lacks in variety it makes up for with interconnectedness.

■ Shaun Prescott



Prey may be set on a space station, but you'll occasionally float around outside of it.

Verdict

A hugely effective disaster sim, but it sadly could be one of the last of its kind.



Night vision helps you navigate dark areas — though some grim sights will make you wish you didn't have it.

STBY



2.8

W O T

50Mbps
1920x1080

PC, PS4, XO | \$59.95 | REDBARRELSGAMES.COM

Outlast 2

It's raining blood! Hallelujah, it's raining blood!

Pure horror is to be endured, not enjoyed, and few games offer tougher tests of tolerance than this first-person terroriser set in the wilds of Arizona. Here all you've got is cowering under beds, ducking inside bins, diving beneath stagnant water, running away, and yelling in terror. Have fun!

You are journalist Blake Langermann who, with his wife Lynn, ventures into the Arizona desert to unravel a murder. It's certainly no coincidence people go missing around here. When the couple's chopper crashes, the investigation turns into a rescue mission. Lynn's not within the wreckage, so Blake makes a move to the mist-shrouded village up ahead. What follows are nervy cat-and-mouse hunts with deranged cultists, frantic running from cannibals and the odd 'find the thing to put in the thing to open the door' puzzle.

Being the cameraman to Lynn's reporter, your camera has a greater presence than in the original *Outlast*. You're no longer merely cowering behind it, you're holding its gaze on grisly sights to

capture them for prosperity, and possibly score some gnarly Tweets in the process.

However, the camera is functionally disjointed. You can only record at set moments, which means you're only pointing your viewfinder where the game tells you, and since you're mostly chronicling static scenes, the only difference marking your footage from another player's is a slight variation in camera wobble.

Outlast 2 takes place mainly in the dark, with only candles and bonfires providing occasional stabs of lighting. You'll have to activate your camera often to utilise its night vision, and while the grainy filter adds to the tension, it's a tiresome way to go. It runs on batteries you scavenge along the way — so if they deplete, night vision does too, and the game is literally unplayable. Night vision should be an option, not a requirement.

This outing does a better job than the first game in terms of spectacle, using the Sonoran Desert's natural splendour as a backdrop for impressive, improbable biblical plagues, from showers of blood to swarms of locusts. Red Barrels times

these moments well, never overloading you with options or overwhelming you with freedom, and this produces a stripped-down and urgent affair. You'll be scared but rarely stuck.

Red Barrels is desperate to tell its story, and it does it through diary snippets, suicide notes, hymn sheets, and religious texts left glowing on tables, which is a clunky, hideously overused way of transmitting story. Not reading them makes you feel like you're missing out, but legging it from murders doesn't really put you in a reading mood.

Outlast 2 is no-holds-barred in its quest to boot you from your comfort zone. Despite not hitting the heights of the first due to its lessened gallows humour, forced night vision and over-reliance on diary entries, it's everything a horror game needs to be — a relief once you're finished. ■ Ben Griffin

Verdict

Uncomfortable, unsettling and truly unpleasant, this is a ferociously effective, yet flawed, horror game.



Little Nightmares

Atmospheric sea-based adventuring.

PC, PS4, XO | \$35

LITTLE-NIGHTMARES.COM

Little Nightmares tasks you with leading a hapless child through an overwhelmingly bleak and sinister world. Much of your time is spent manoeuvring around the obstacles of the eerily dark, abandoned rooms of The Maw — a hellish vessel filled with unsavoury people. The atmosphere is splendidly haunting, the story reinforced by some clever lighting effects. Don't be fooled by its depressing surface — *Little Nightmares* is a real joy to play.

Navigating The Maw's rooms involves a clever blend of puzzling and platforming. There's an obvious and admirable attention to detail as you can interact with almost everything in the world — even if they don't have a distinct purpose. These intricacies help to give a tangible quality to the game's macabre world. The camera also sways back and forth, giving a sense of being at sea. It's another simple touch, but it adds immeasurably to the game's engrossing nature.

While the puzzles are inventive, they don't overly challenge you. It's hard to put down and you'll find yourself reaching its mystifying conclusion within four hours.

Nonetheless, there's a definite emphasis on quality over quantity here, and the well-crafted, intense and memorable experience that the game provides is more than enough incentive to warrant a return trip. ■ Anne-Marie Coyle

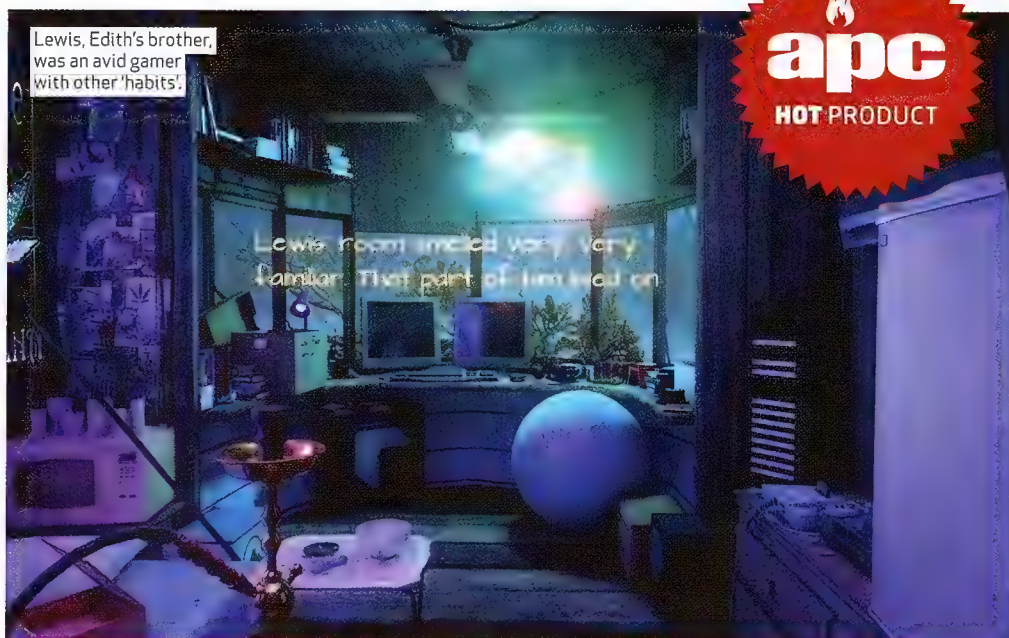




Rime

A boy's journey.
PC, PS4, XO, SWITCH
\$60 | TEQUILAWORKS.COM

Rime asks nothing more of you than a little curiosity and some basic puzzle-solving nous, and delivers a sprawling, ambitious adventure in return. There's little in the way of guidance or justification — you're left to uncover the secrets of this enigmatic place yourself. Some objects on the island react to your presence, and this mechanic forms the backbone of many of the game's puzzles. Despite the variety of ideas on show, the devs deploy conundrums sparingly and in such a way that they feel like a natural part of the world rather than contrived gating. While the way forward is often just the other side of a bottleneck, there are usually tempting alternative paths to mine for the game's various collectables and secrets. None of the puzzles are likely to hold you up for long; while a handful take a little thinking about, none provide a particularly steep challenge. Nor do they represent much of a break in the pace of the game, which moves along in a languid manner even when the handful of threats that exist in the game present themselves. There's no combat as such, but on the few occasions that you find yourself in danger, there's usually an indirect way to fight back. The devs have struck a welcoming balance between open-world exploration and gentle funnelling, and in the process, have created an uncommonly beautiful, open-hearted game.



PC, PS4 | \$30 | WWW.EDITHFINCH.COM

What Remains of Edith Finch

Step into another family home.

Edith Finch's family has a habit of dying young, so she's trying to get to the bottom of the curse before she, at the age of 17, also becomes a victim.

This game begins as a *Gone Home*-like exploration into an empty Pacific North-western home. The most striking thing about the Finch manor is how normal it is. It looks like a house that people lived in, built to proper proportions and furnished in an entirely mundane manner, albeit with more books than you may expect. The sealed rooms are strange, but in a way, that speaks of eccentricity rather than anything sinister.

Then we discovered the shrine to Molly Finch, who died in 1947 at ten years of age. Molly's story is as out-of-left-field as anything we've ever encountered in a video game and it ended on a note of unexpected, disturbing darkness.

The family stories told in *What Remains of Edith Finch* are filtered through the lens of time, and the closer they come to Edith's own life, the less fantastical they seem. Most of us probably know

someone like Lewis, a kind young man with a keen mind who just couldn't find his way in this world. And even when the story moves into unambiguously dangerous territory — the death of an infant, which you will not just witness but participate in — it does so with remarkable grace.

Edith Finch is a guided tale with few opportunities to explore off the beaten path. There's no inventory or choices to be made, and while hotspots require a bit of exploring nothing is really hidden. But the stories of the Finch family more than make up for that narrow focus. Reading each of the memorials to family members took me on a unique adventure through different first-person formats: we got to know Grandpa Sam through the lens of a manual-focus camera, we flew a kite with Gus over a beach, we even became the ruler of a video game kingdom. It was amazing to see so many different styles handled so well in a single game.

We were frustrated at first by the checkpoint save system but they soon became irrelevant: *What Remains of*

Edith Finch isn't a long game and it was so enthralling that we had no interest in stopping.

As the branches of Edith's family tree grow closer to her own life, it enables her to speak more personally about them — a shift in perspective that gives her words an emotional heft that's lacking when she's reflecting on someone she never met.

The end of the game was intensely sad: we could feel the inevitability of Edith and Great-Grandmother Edie's looming last day together and dreaded it. You will feel as though you've grown to understand these Finches, and you will miss them knowing they're gone.

This is a masterful piece of storytelling — deftly told, uplifting in places and devastating in others. Avoid spoilers (we can't think of a game more in need of being unspoiled than this one) and experience it. ■ Andy Chalk

Verdict

Touching, sad and brilliant. You can forgive this story's limited interactivity, as it gives so much back in experience.





PC | \$89 | WWW.DAWNOFWAR.COM

apc
RECOMMENDS

Dawn of War III

Relic goes back to the basics (and bases).

We can't help but sit back and admire *Warhammer 40,000: Dawn of War III's* outlandish swagger. Here, we find ourselves in a futuristic world so advanced that people flit about in spacecraft as easily as we take the bus, and yet despite all of the cybernetics and high-tech weaponry, one of its great heroes is a guy wielding a big frickin' hammer.

DoW III is all about recapturing that classic real-time strategy excitement. Much of the time, it succeeds. Some good elements from the past get lost in the process, such as the cover system and *Diablo*-style loot hunts that helped make 2009's *DoW II* so exciting, but nothing shines so brightly in this new outing as the unrelenting action.

With a better story, it may have been magnificent. It certainly has the ingredients on hand — a dash of old,

favourite characters like the Eldar's Farseer Macha and the Orkish warboss Gorgutz 'Ead 'Unter — but the game squanders it on a tale about the races brutally bickering over a mysterious spear and some business about a runaway planet.

The big difference this time around is that *III* lets you play all three factions in the 17-mission campaign rather than limiting yourself to the Space Marines, which was one of the greatest joys this game has to offer.

Each race is distinct. The Marines are a straightforward lot with swords and guns, but they march with panache, mowing down Orks and Eldar with hulking mechs or Gabriel's hammer. The Eldar are a band apart. Lithe and lean, they dart across the battlefield with rechargeable shields and an emphasis on strike-and-run tactics, and they can teleport almost all of their base's structures across the field rather than build a new one.

But the Orks can upgrade themselves with the scrap from ruined buildings, and their ramshackle structures invites admiration. Nothing sets them apart quite like their WAAAGH! Towers, though, which look like they might be loaded on *Mad Max: Fury Road's* Doof Wagon and which pump out heavy metal to the green hordes.

Forums leading up to the official launch crawled with complaints that it looked too 'cartoony', but the graphical approach here generally works well in action.

It can get tough to see all these units in action, particularly when the screen floods with little green men, but the intuitive user interface usually smooths out any potential issues. Every squad that's either in the field or being prepared gets its own little square at the bottom of the screen, making it easy to keep track of which ones are taking fire.

It's usually safe to expect a dull campaign from an RTS

game. The joke-that's-not-a-joke goes that they're really only meant as tutorials for the multiplayer, and that's true here. The catch? *Dawn of War III* does a shoddy job of it. Rather than sending you through multiple missions at a time with a single faction, Relic passes you off to a different one every mission. Just as we're getting comfy with one group's tactics, we're asked to move to another.

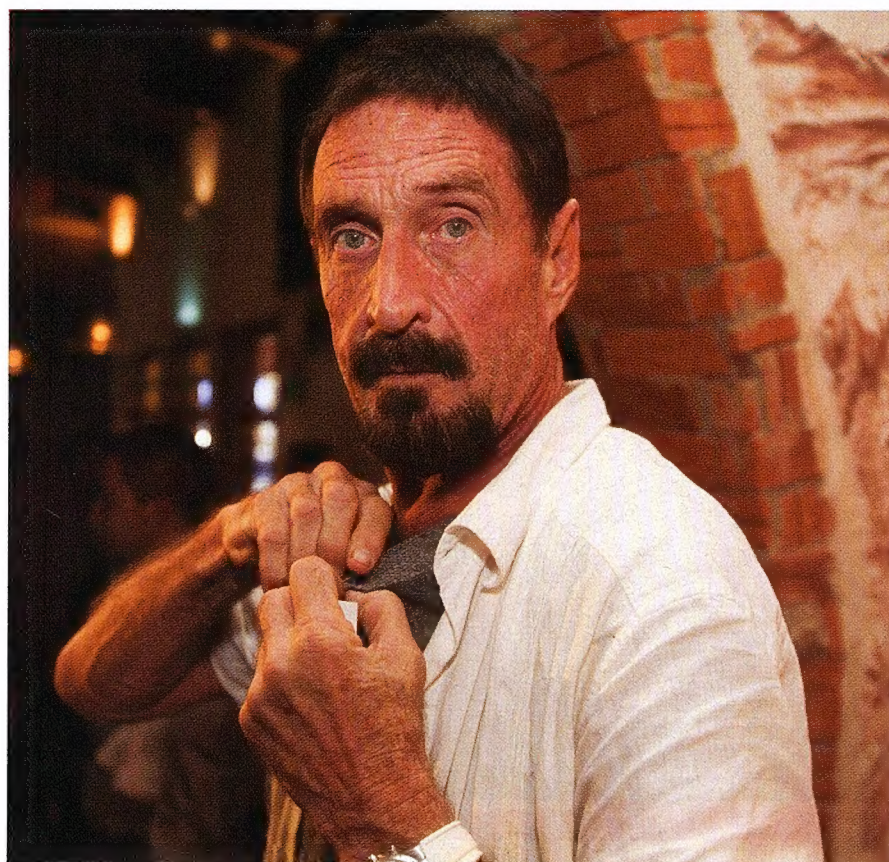
We admire *DoW III* for trying to reinvent its formula again. In its finest moments, when armies are crawling over each other and mechs make the ground tremble, it's a rather exciting place to be.

■ Leif Johnson

Verdict

Not the pure RTS feel of the first, or the experimental RPG of the second — it's somewhere in the middle.





Johnny Depp to star as notorious antivirus pioneer John McAfee in new biopic

The king of weird finds himself in the jungle.

While the movie title *King of the Jungle* has us conjuring up pictures of either Tarzan or tigers (or both), it's actually a dark comedy about John McAfee — the man behind the famous antivirus software. Based on the ebook *John McAfee's Last Stand* by Wired magazine's Joshua Davis, the story will revolve around a journalist's trip to Belize to interview McAfee. Now while it might seem strange to hear that Johnny Depp isn't playing a vampire, pirate or some kind of weird sub-human monster, it turns out that McAfee's life in Belize was apparently rife with guns and sex. So... perfect for Johnny Depp, after all!

Russian man jailed for inappropriate *Pokémon GO*ing

A WILD LAW APPEARS!

While it's not our place to criticise other countries' laws with regards to, well, anything, we can't help but raise our eyebrows at this. Ruslan Sokolovsky, a Russian blogger, has recently been given a 3.5-year suspended jail sentence after he posted a video online in which he was playing *Pokémon GO* in a church, in what Russian authorities have described as showing "disrespect for society". The charges include "violating religious feelings" and "illegal possession of special technical means", which refers to a pen that, prosecutors claim, had a camera inside it — although Sokolovsky denies this. The blogger has expressed his dismay and called his sentencing an act of "savagery and barbarism".



Oh, great, we're putting emoji on buildings now?

WHAT A RELIEF! (SORRY, SORRY...)

So this is a thing. The human race has finally reached its apex — there's nothing better than this. Architect Changiz Tehrani had the idea to try something different in adorning a newly constructed building in the historic Dutch city of Amersfoort. Instead of adding "heads of the king or whatever", he decided to go for something more universal in appeal — emoji. While, from afar, it's hard to tell what the circular reliefs actually depict (which is probably a good thing for those who may find this choice in masonry a bit stupid), up close, there's no mistaking the 'Smiling Face With Heart-Eyes', 'Winking Face', 'Flushed Face' or 'Face Blowing a Kiss'. Personally, we're not sure our feelings about this can be expressed in words. Instead, we refer to the capable... 🙄

Dorkwood	61	63	66
Flower	178	184	196
Sand Dan	201	172	143
Grade Bat	48	94	83
Light Of Blast	175	150	147
Grass Bat	176	99	108
Sindis Poop	204	205	194
Dope	219	209	179
Testing	156	101	106
Stoner Blue	152	165	159
Burble Simp	226	181	132

AI creates and names a new bunch of colours

AND A NEW LANGUAGE, BY THE LOOKS OF IT.

Liberation. Hint of winter. Water scout. Peppermint sky. Soul pea. Sinatra swoon. Blessed. Spiced summers. Geese. We could go on. These are just some of the ridiculous names humans have come up with to name certain hues on their paint colour charts, so how could an AI do any worse? Janelle Shane, a research scientist and neural networking expert, recently trained an AI to come up with new colours and to give them "attractive names". It wasn't entirely successful, however, as some of the names given varied from "Caae Blae" to "Bylfgoam Glos" — and, amusingly, "Snowbonk", "Bank Butt" and "Stoner Blue". ■



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